

SMOKY-SALINE RIVER BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Smoky Hill River, Salina to Junction City
Water Quality Impairment: Total Phosphorous

1. INTRODUCTION

Subbasin: Lower Smoky Hill

Counties: Dickinson (DK), Geary (GE), McPherson (MP), and Saline (SA)

HUC8: 10260008

HUC10 (12): **08** (01, 02, 03, 04, 05)

07 (06)

04 (03)

03 (02, 03, 04, 05, 06, 07)

Ecoregions: Smoky Hills (27a) and Flint Hills (28a)

Drainage Area: 491 mi²

Main Stem Water Quality Limited Segments and Tributaries (Figure 1; designated uses are detailed in **Table 1**):

Main Stem

HUC8 10260008

Smoky Hill River (13)

Smoky Hill River (12, 11, 10, 9)

Smoky Hill River (6)

Smoky Hill River (2)

Smoky Hill River (1)

Tributaries

Pewee Cr (56; unimpaired)

Dry Creek (36)

Dry Creek East (43)

Lone Tree Creek (41)

Otter Creek (42)

Table 1. Designated uses for main stem and tributary segments in the Smoky Hill River from Mentor to Junction City (Kansas Department of Health and Environment, 2013).

Stream	Segment	Aquatic Life	Contact Recreation	Domestic Supply	Food Procurement	Groundwater Recharge	Industrial	Irrigation	Livestock Watering
<i>HUC8: 10260008</i>									
Smoky Hill R	13	E	B	Y	Y	Y	Y	Y	Y
Pewee Cr	56	E	b	Y	N	Y	Y	Y	Y

Stream	Segment	Aquatic Life	Contact Recreation	Domestic Supply	Food Procurement	Groundwater Recharge	Industrial	Irrigation	Livestock Watering
<i>HUC8: 10260008 (continued)</i>									
Dry Cr	36	E	b	N	N	Y	Y	Y	Y
Dry Cr East	43	E	b	N	N	Y	N	Y	Y
Smoky Hill R	12	E	C	Y	Y	Y	Y	Y	Y
Smoky Hill R	11	E	C	Y	Y	Y	Y	Y	Y
Smoky Hill R	10	E	C	Y	Y	Y	Y	Y	Y
Smoky Hill R	9	E	C	Y	Y	Y	Y	Y	Y
Smoky Hill R	6	E	C	Y	Y	Y	Y	Y	Y
Lone Tree Cr	41	E	A	Y	N	Y	Y	Y	Y
Smoky Hill R	2	E	C	Y	Y	Y	Y	Y	Y
Smoky Hill R	1	E	C	Y	Y	Y	Y	Y	Y
Otter Cr	42	E	b	Y	Y	Y	Y	Y	Y

Definitions: E - expected aquatic life use water; B - primary contact recreation stream; Y - referenced stream segment is assigned the indicated designated use; b - secondary contact recreation stream; N - referenced stream segment does not support the indicated designated use; C - primary contact recreation stream

303(d) Listings for Total Phosphorus and Biology

Station SC514 (**Figure 2**), Smoky Hill River near Mentor.

Station SC268 (**Figure 2**), Smoky Hill River near Salina.

Total Phosphorus Impairment, Category 5: 2008, 2010, 2012, 2014, 2016, and 2018.

Biology Impairment, Category 5: 2002.

Category 4a: 2004, 2008, 2010, 2012, 2014, 2016, and 2018.

Station SC265 (**Figure 3**), Smoky Hill River at Enterprise.

Total Phosphorous Impairment, Category 5: 2008, 2010, 2012, 2014, 2016, and 2018.

Biology Impairment, Category 4a: 2004, 2008, 2010, 2012, 2014, 2016, and 2018.

Station SC264 (**Figure 4**), Smoky Hill River at Junction City.

Total Phosphorous Impairment, Category 5: 2008, 2010, 2012, 2014, 2016, and 2018.

Biology Impairment, Category 5: 2008, 2010, 2012, 2014, 2016, and 2018.

Figure 1. Map of contributing area for Kansas Department of Health and Environment stream chemistry (SC) stations on the Smoky Hill River from Mentor to Junction City.

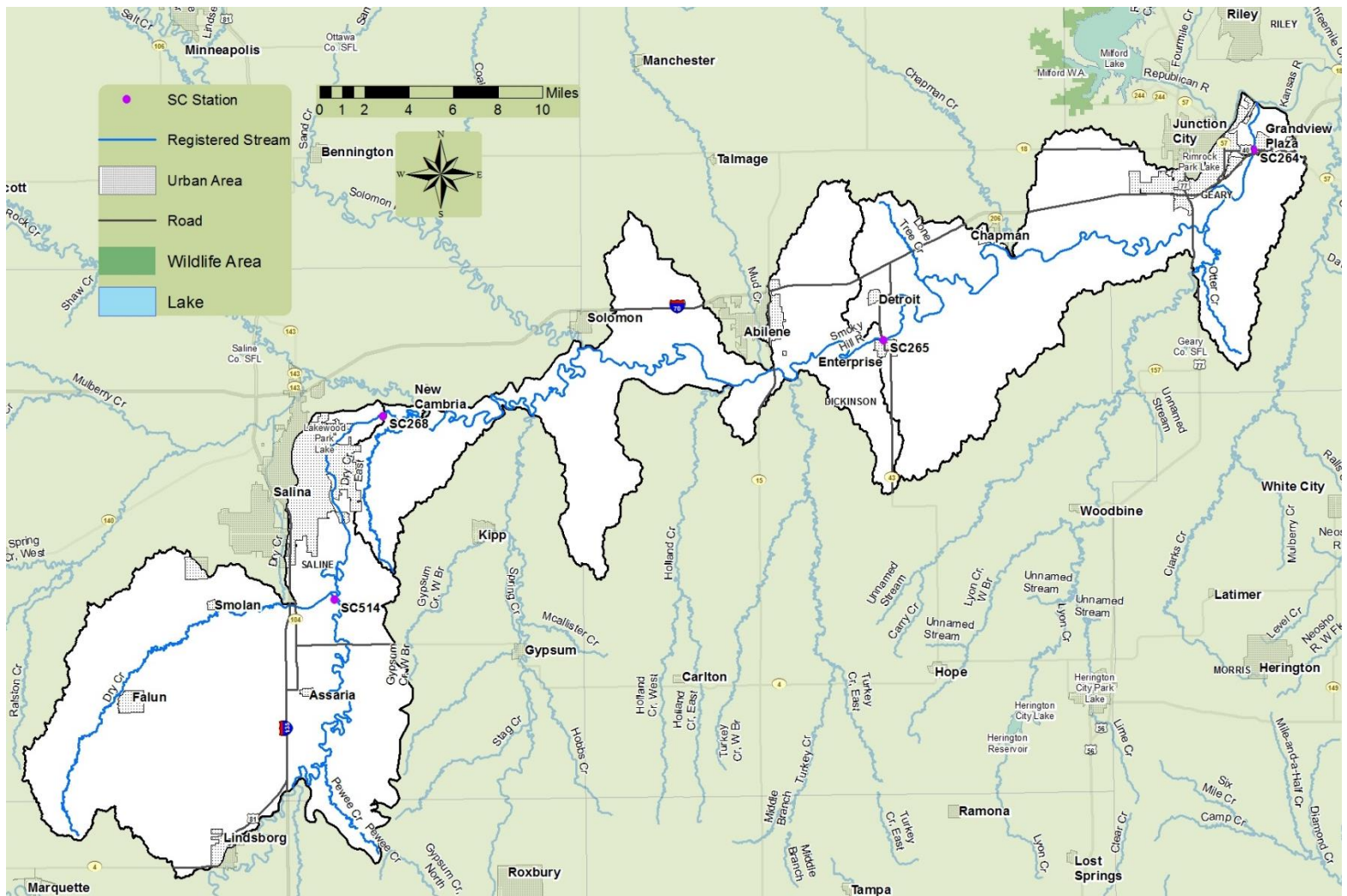


Figure 2. Map of contributing area for Kansas Department of Health and Environment stream chemistry (SC) station on the Smoky Hill River near Salina (SC268).

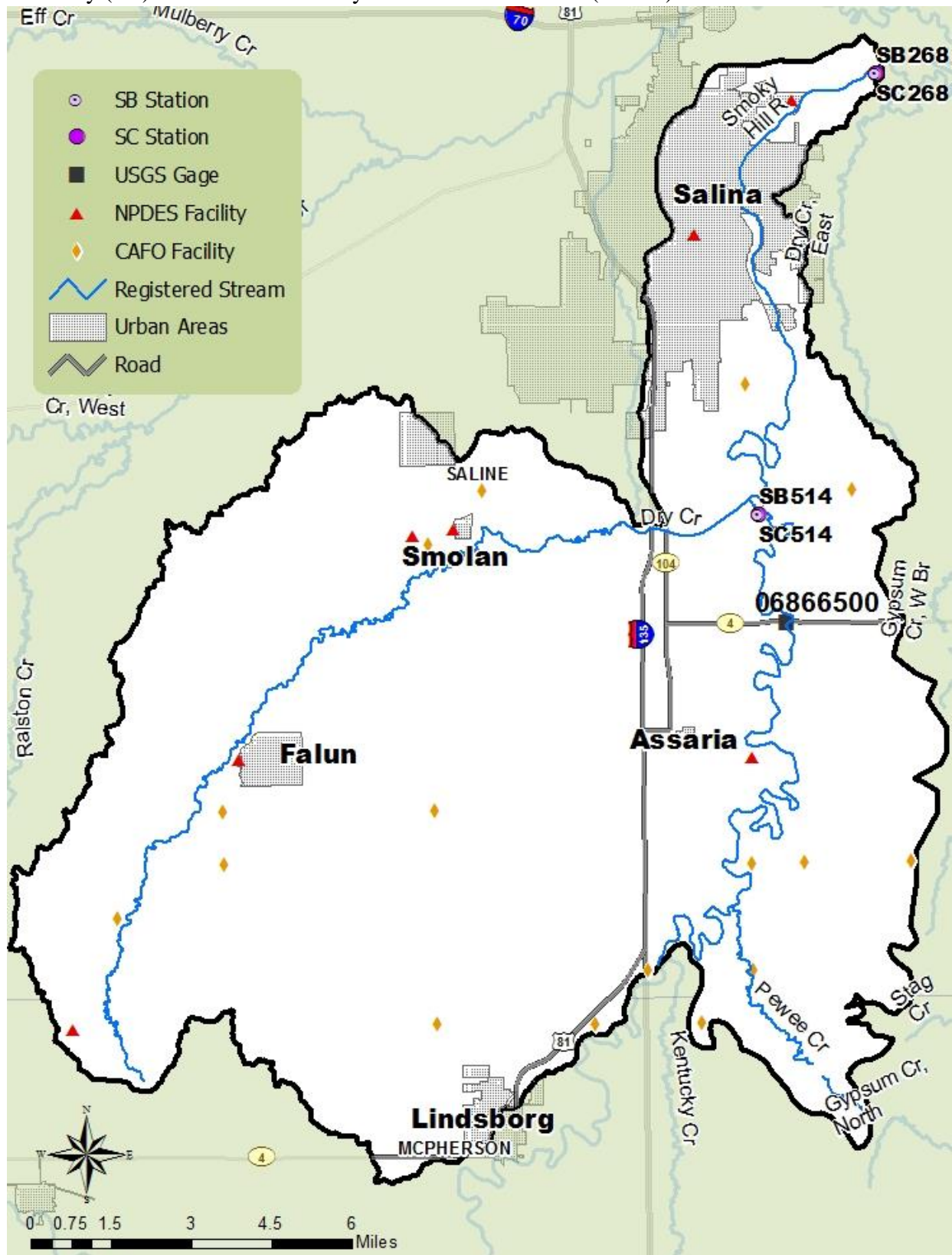


Figure 3. Map of contributing area for Kansas Department of Health and Environment stream chemistry (SC) station on the Smoky Hill River at Enterprise (SC265).

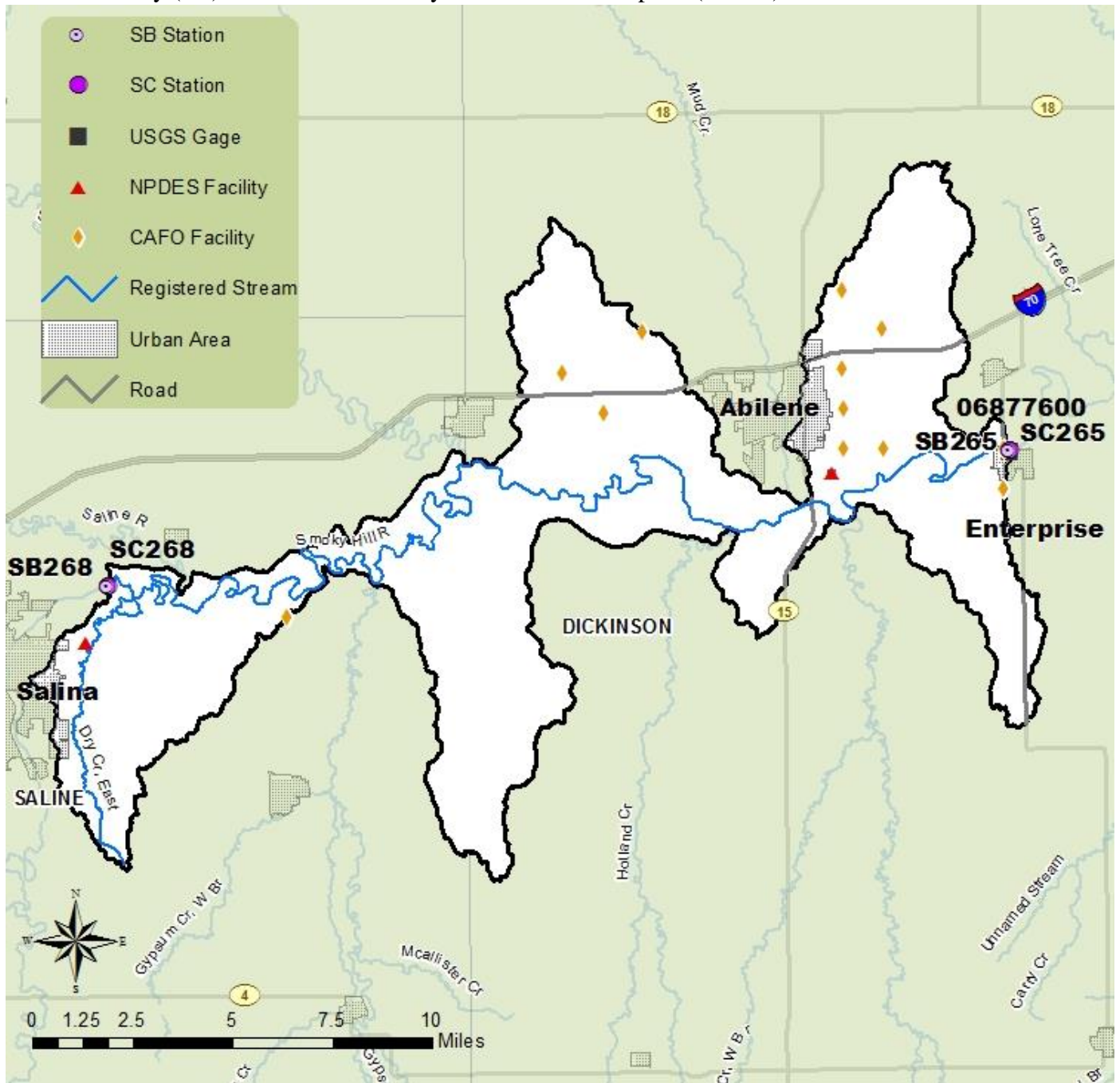
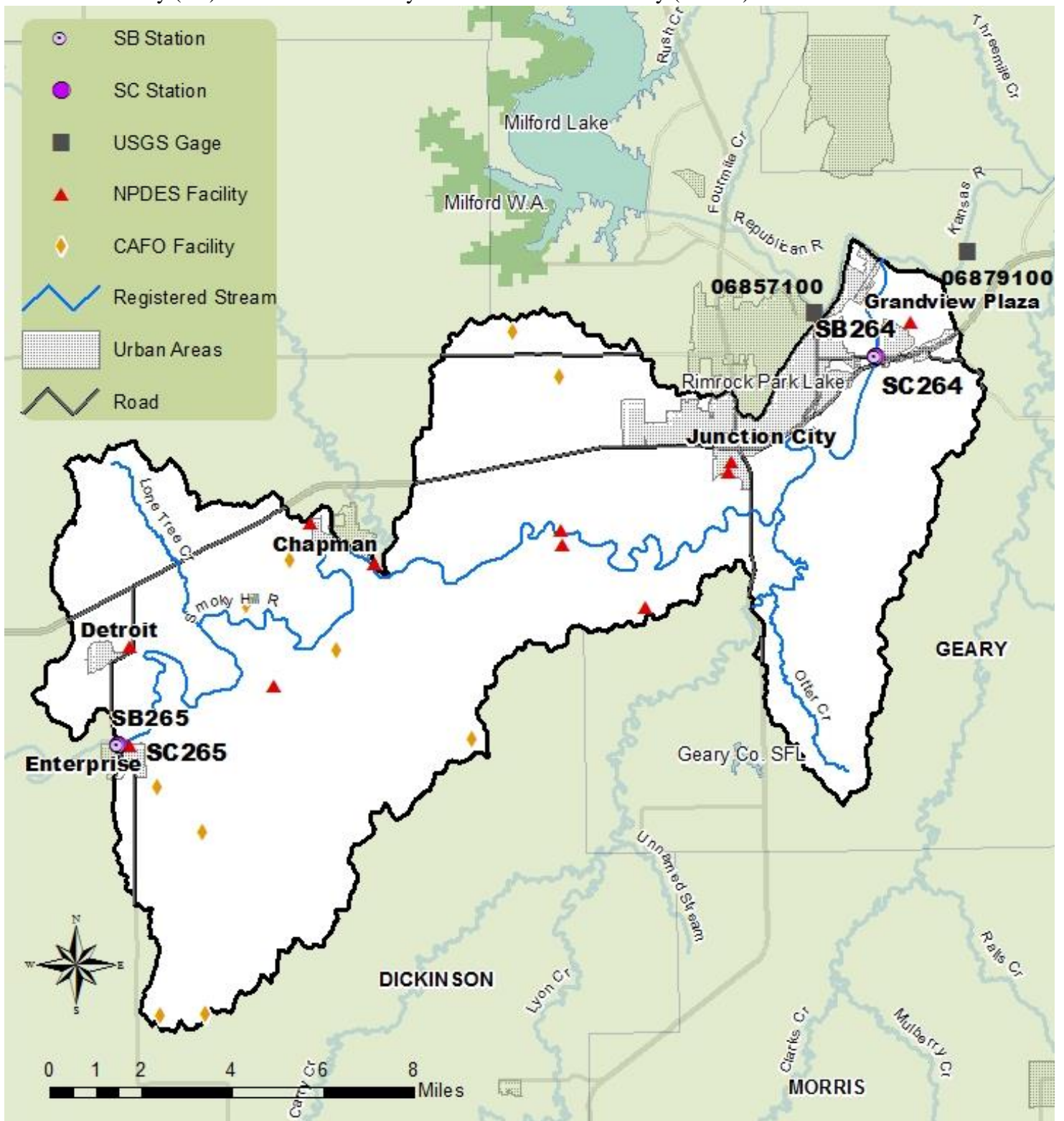


Figure 4. Map of contributing area for Kansas Department of Health and Environment stream chemistry (SC) station on the Smoky Hill River at Junction City (SC264).



Impaired Use

Expected Aquatic Life, Contact Recreation, and Domestic Water Supply.

Water Quality Criteria

Narrative Nutrient Criteria

The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement of aquatic biota or the production of undesirable quantities or kinds of aquatic life (K.A.R. 28-16-28e(d)(2)(A)).

The introduction of plant nutrients into surface waters designated for domestic water supply use shall be controlled to prevent interference with the production of drinking water (K.A.R. 28-16-28e(d)(3)(D)).

The introduction of plant nutrients into surface waters designated for primary or secondary contact recreational use shall be controlled to prevent the development of objectionable concentrations of algae or algal by-products or nuisance growths of submersed, floating, or emergent aquatic vegetation (K.A.R. 28-16-28e(d)(7)(A)).

Taste-producing and odor-producing substances of artificial origin shall not occur in surface waters at concentrations that interfere with the production of potable water by conventional water treatment processes, that impart an unpalatable flavor to edible aquatic or semiaquatic life or terrestrial wildlife, or that result in noticeable odors in the vicinity of surface waters (K.A.R. 28-16-28e(b)(7)).

Numeric Dissolved Oxygen Criteria

The concentration of dissolved oxygen in surface waters shall not be lowered by the influence of artificial sources of pollution. The Dissolved Oxygen criterion is 5 mg/L (K.A.R. 28-16-28e(e)).

Numeric pH Criteria

Artificial sources of pollution shall not cause the pH of any surface water outside of a zone of initial dilution to be below 6.5 and above 8.5 (K.A.R. 28-16-28e: Tables of Numeric Criteria).

2. CURRENT WATER QUALITY CONDITIONS AND DESIRED ENDPOINT

Level of Support for Designated Uses under 2018 303(d)

Phosphorus levels in watersheds in the Smoky Hill River from Salina (SC268) to Junction City (SC264) are consistently high. Excessive nutrients are not being controlled and are thus impairing aquatic life, contact recreation, and domestic water supply. The ultimate endpoint of this Total Maximum Daily Load (TMDL) will be to achieve the Kansas Surface Water Quality Standards by eliminating excessive primary productivity and impairment to aquatic life, recreation, and domestic water supply associated with excessive phosphorus.

Station Location and Period of Record

Stream Chemistry (SC) Monitoring Stations

- SC514: Active permanent station on the Smoky Hill River near Mentor, located on County Road Bridge 1.5 miles east of Mentor. Period of record: March 14, 1990 to September 11, 2017.
- SC268: Active permanent station on the Smoky Hill River near Salina, located on County Road Bridge 4.0 miles east and 1.5 miles north of Salina. Period of record: March 14, 1990 to September 11, 2017.
- SC265: Active permanent station on the Smoky Hill River at Enterprise, located on K-43 Highway Bridge in Enterprise. Period of record: March 14, 1990 to September 11, 2017.
- SC264: Active rotational station on the Smoky Hill River at Junction City, US-40 Alternate Highway Bridge 1.5 miles east of Junction City. Period of record: January 4, 1996 to December 8, 2014.

Stream Biology (SB) Monitoring Stations

- SB514: Active station on the Smoky Hill River near Mentor, located on County Road Bridge 1.5 miles east of Mentor. Period of record: October 20, 1993 to July 31, 1996.
- SB268: Active station on the Smoky Hill River near Salina, located on County Road Bridge 4.0 miles east and 1.5 miles north of Salina. Period of record: September 26, 1990 to July 8, 2015.
- SB265: Active station on the Smoky Hill River at Enterprise, located on K-43 Highway Bridge in Enterprise. Period of record: August 9, 2010.
- SB264: Active station on the Smoky Hill River at Junction City, US-40 Alternate Highway Bridge 1.5 miles east of Junction City. Period of record: July 19, 1990 to June 28, 2016.

Streamflow Gages

- U.S. Geological Survey 06865500: Smoky Hill River near Langley. Period of record: January 1, 1990 to September 30, 2017. Located below Kanopolis Reservoir.
- U.S. Geological Survey 06866500: Smoky Hill River near Mentor. Period of record: January 1, 1990 to September 30, 2017. Located near SC514, SB514, SC268, and SB268.
- U.S. Geological Survey 06877600: Smoky Hill River at Enterprise. Period of record: January 1, 1990 to September 30, 2017. Located near SC265 and SB265.
- U.S. Geological Survey 06857100: Republican River at Junction City. Period of record: January 1, 1990 to September 30, 2017. Located near SC264 and SB264.
- U.S. Geological Survey 06879100: Kansas River at Fort Riley. Period of record: January 1, 1990 to September 30, 2017. Located near SC264 and SB264.

Hydrology

Flow conditions for this TMDL were analyzed using U.S. Geological Survey (USGS) streamgage data from the Smoky Hill River near Mentor (06866500), Smoky Hill River at Enterprise (06877600), Republican River at Junction City (06857100), and Kansas River at Fort Riley (06879100). All USGS gages have streamflow data available for the period of record January 1, 1990 to September 30, 2017.

Flow conditions for the Kansas Department of Health and Environment (KDHE) stream chemistry (SC) stations Smoky Hill River near Mentor (SC514) and Smoky Hill River near Salina (SC268) were calculated using a watershed area ratio based upon the USGS Smoky Hill River near Mentor (06866500) streamgage and its drainage area (**Table 2**). Flow conditions for the Smoky Hill River at Enterprise (SC265) are based upon streamflow measurements at the USGS Smoky Hill River at Enterprise (06877600) streamgage. Flow conditions and drainage area for the Smoky Hill River at Junction City (SC264) are estimated based upon the difference between the USGS Kansas River at Fort Riley (06879100) and the USGS Republican River at Junction City (06857100) streamgages.

Table 2. Flow conditions and drainage area at U.S. Geological Survey gages and Kansas Department of Health and Environment stream chemistry (SC) stations in the Smoky Hill River from Mentor to Junction City.

Stream	Station	Contributing Drainage Area (mi ²)	Mean Flow (cfs)	Percent Flow Exceedance (cfs)				
				90%	75%	50%	25%	10%
Smoky Hill R nr Mentor	06866500	8,341	311	26	50	107	256	655
Smoky Hill R nr Mentor	SC514	8,348	311	26	50	107	256	656
Smoky Hill R nr Salina	SC268	8,509	317	26	51	109	261	668
Smoky Hill R at Enterprise	06877600/SC265	19,260	1,449	143	228	564	1,370	3,530
Smoky Hill R at Junction City	SC264	19,970	1,752	184	318	719	1,694	4,230
Republican R at Junction City	06857100	24,900	735	30	52	205	689	1,910
Kansas R at Fort Riley	06879100	44,870	2,488	298	481	1,050	2,550	5,950

Flow duration curves for the USGS gages at Smoky Hill River near Mentor and Smoky Hill River at Enterprise, as well as estimated values for the Smoky Hill River at Junction City, are displayed in **Figure 5**. Streamflow near Mentor is approximately five to seven times lower than streamflows at downstream Enterprise and Junction City, due to increased drainage area and the confluence of the Saline and Solomon Rivers with the Smoky Hill River just before Enterprise. This trend is consistent throughout all but the highest and lowest flows.

Long-term estimated flows for the Smoky Hill River and its tributaries can be found in **Table 3** (Perry et al., 2004). The main tributary to the Smoky Hill River near Mentor (SC514) is Pewee Creek, and the main tributary to the Smoky Hill River near Salina (SC268) is Dry Creek. After these tributaries enter the Smoky Hill River, the river continues along the outskirts of the City of Salina before its confluence with the Saline River. Previously, the Smoky Hill River ran through the middle of the City of Salina, but the river's course was changed in the 1960s with the addition of a bypass channel and a flood control levee constructed by the U.S. Army Corp of Engineers (City of Salina, 2018). Today, the old riverbed is used as a stormwater channel for the city storm drains but has no base flow. Major tributaries to the Smoky Hill River at Enterprise (SC265) include the Saline River and Solomon River. Major tributaries to the Smoky Hill River at Junction City (SC264) include Chapman Creek and Lyon Creek.

Figure 5. Flow duration curve for U.S. Geological Survey (USGS) gaged sites located in the Smoky Hill River (06866500 and 06877600) and estimated flow duration curve based upon USGS gaged sites located in the Republican River (06857100) and Kansas River (06879100).

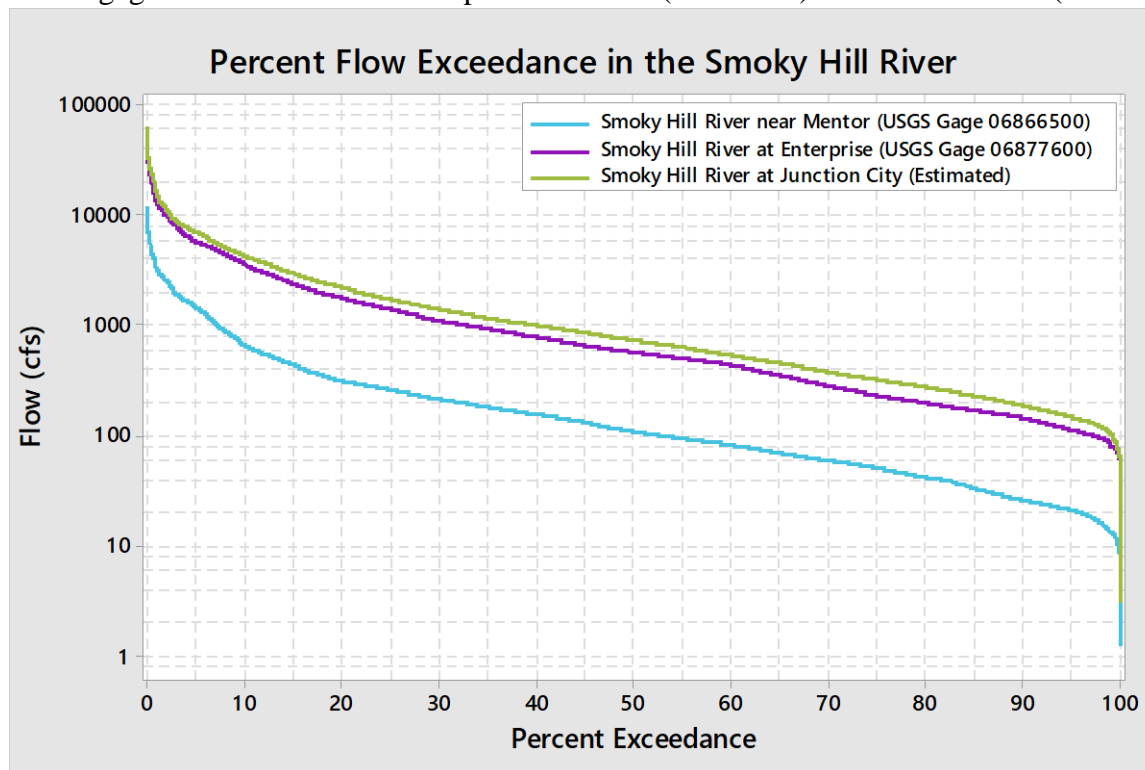


Table 3. U.S. Geological Survey (USGS) long-term estimated flows for the Smoky Hill River and its tributaries from Mentor to Junction City (Perry et al., 2004).

Stream	USGS Site	KSWR CUSEGA Number	County	Drainage Area (mi ²)	Mean Flow (cfs)	Percent Flow Exceedance (cfs)					2-year Peak (cfs)
						90%	75%	50%	25%	10%	
Smoky Hill R	2638	1026000813	SA	8,360	341	34	61	115	272	851	3,570
Pewee Cr	2680	1026000856	MP, SA	11	4	0	0.4	1	2	5	745
Smoky Hill R	2607	1026000813	SA	8,403	351	36	64	120	284	876	3,780
Dry Cr	2484	1026000836	SA	100	28	0	2	6	16	39	1,720
Smoky Hill R	2388	1026000813	SA	8,524	381	41	72	135	315	948	4,360
East Dry Cr	2297	1026000843	SA	20	7	0	0.2	2	3	8	1,040
Smoky Hill R	2207	1026000813	SA	8,550	383	41	72	136	317	954	4,370
Saline R	2191	102600101	SA	3,320	237	18	29	55	149	563	2,720
Smoky Hill R	2206	1026000812	SA	11,900	688	71	116	224	557	1,870	6,050
Gypsum Cr	2334	1026000818	SA	284	83	1	5	20	50	129	3,180
Smoky Hill R	2185	1026000811	SA	12,200	722	75	123	238	592	1,950	6,300
Solomon R	2103	102600151	SA	6,910	563	57	85	174	458	1,400	5,200
Smoky Hill R	2144	1026000810	SA, DK	19,100	1,510	182	288	573	1,410	3,810	12,000
Holland Cr	2163	1026000825	DK	103	44	0	2	8	24	64	2,870
Smoky Hill R	2130	102600086	DK	19,200	1,530	184	290	578	1,430	3,830	12,100

Stream	USGS Site	KSWR CUSEGA Number	County	Drainage Area (mi ²)	Mean Flow (cfs)	Percent Flow Exceedance (cfs)					2-year Peak (cfs)
						90%	75%	50%	25%	10%	
Mud Cr	2127	102600088	DK	130	45	1	4	12	28	68	2,570
Smoky Hill R	2142	102600086	DK	19,400	1,540	186	294	584	1,440	3,870	12,200
Turkey Cr	2301	1026000828	DK	181	79	0	3	12	40	116	2,960
Smoky Hill R	2141	102600086	DK	19,600	1,570	190	299	595	1,470	3,930	12,400
Lone Tree Cr	2049	1026000841	DK	33	16	0	1	3	9	22	2,560
Chapman Cr	2017	102600083	DK	313	93	8	13	24	49	126	3,630
Smoky Hill R	2027	102600082	DK, GE	20,000	1,590	193	305	608	1,500	3,990	12,500
Otter Cr	2118	1026000842	GE	15	8	0	0	1	3	9	1,220
Lyon Cr	2037	1026000831	GE	312	118	4	17	35	70	152	6,620
Smoky Hill R	1864	102600081	GE	20,300	1,610	196	309	618	1,530	4,040	12,600

Definitions: SA - Saline; MP - McPherson; DK - Dickinson; GE - Geary; **Segments with stream chemistry stations**

The highest mean annual flows in the Smoky Hill River near Mentor occurred in 1993, 1995, 1998, and 2007, with flows of: 1,891; 621; 618; and 590 cubic feet per second (cfs), respectively (**Figure 6**). The highest median annual flows occurred in 1993, 1998, and 2008, with flows of: 1,570; 354; and 332 cfs, respectively. Annual mean and median flows were lowest in 2006 and 2012, with means of 26 and 31 cfs, respectively, and medians of 25 and 23 cfs, respectively.

Trends in annual flows generally coincide with National Oceanic and Atmospheric Administration (NOAA) annual total precipitation from station USC00145363 in Minneapolis. The highest annual precipitation occurred in 1993 and 1998, corresponding to some of the years with highest annual flows. The lowest annual precipitation occurred in 2012, corresponding to one of the lowest years of flow. However, flow is most strongly influenced by the presence of Kanopolis Reservoir upstream of this station. Releases from Kanopolis Reservoir, as measured at the USGS gage near Langley (06865500), indicate that the majority of flow in the Smoky Hill River near Mentor is contributed from this reservoir.

The peak annual flows in the Smoky Hill River near Mentor occurred in 1993, 1995, and 1998, with flows of: 11,900; 8,810; and 8,660 cfs, respectively (**Figure 7**). The lowest peak annual flows occurred in 2006 and 2012, with flows of 118 and 258 cfs, respectively. The highest peak annual flows generally coincide more strongly with precipitation and the lowest peak annual flows generally correspond to flow contributed from Kanopolis Reservoir.

Seasonally in the Smoky Hill River near Mentor, high flows occur in spring (April through June) and low flows occur in winter (November through March; **Figure 8**). Spring flows are skewed by high flow events, likely due to precipitation and runoff events, and correspond to higher flows in May and June. Meanwhile, winter low flows correspond to the months of January and February.

Figure 6. Annual mean and median flows in the Smoky Hill River for U.S. Geological Survey gages 06865500 near Langley (below Kanopolis Reservoir) and 06866500 near Mentor, located near Mentor (SC514) and Salina (SC268), and annual total precipitation at National Oceanic and Atmospheric Association station USC00145363 at Minneapolis.

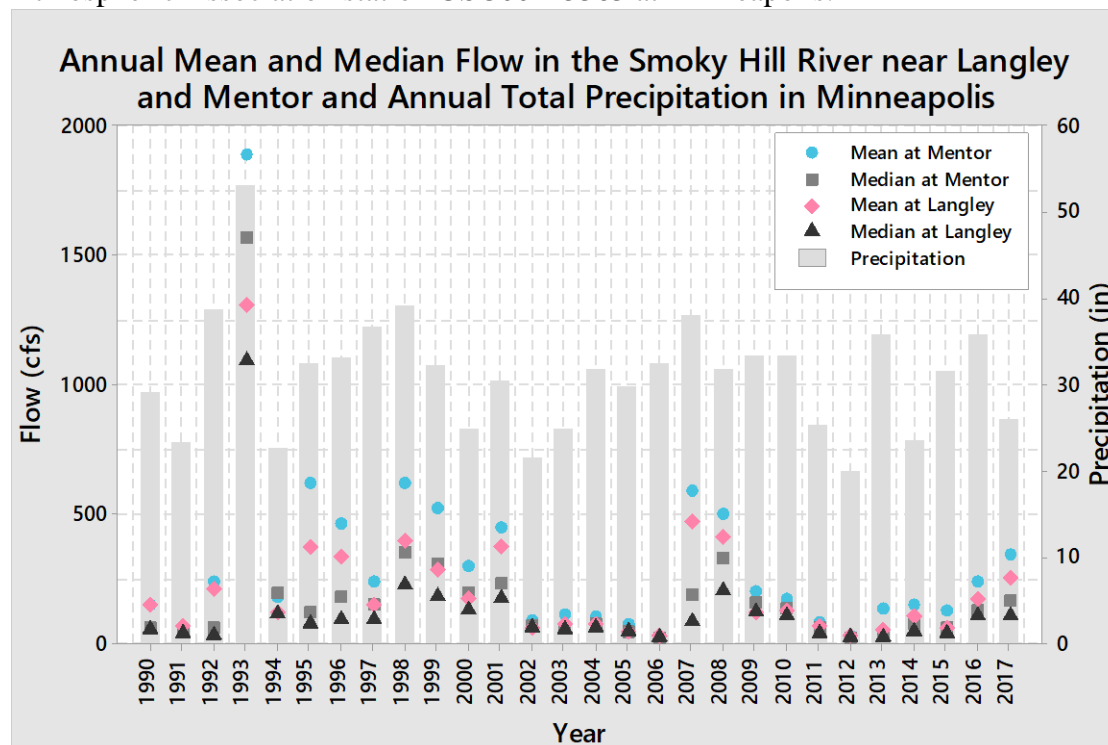


Figure 7. Annual peak flows for U.S. Geological Survey gage 06866500 at Mentor, located near Mentor (SC514) and Salina (SC268) in the Smoky Hill River.

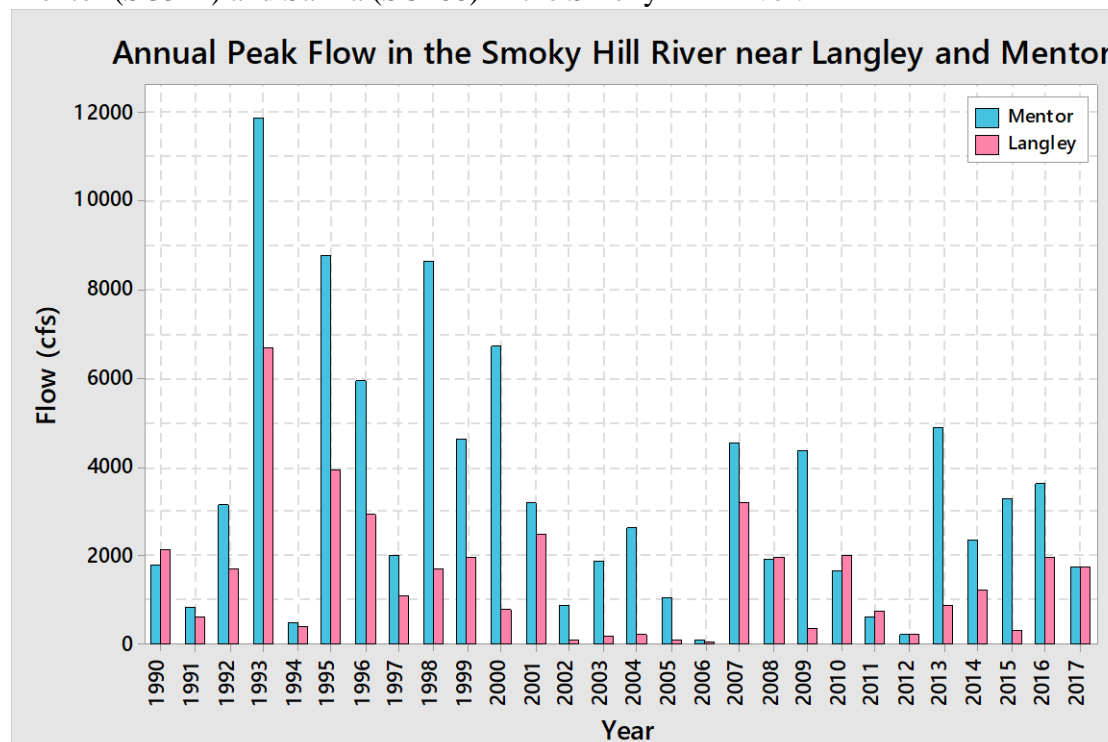
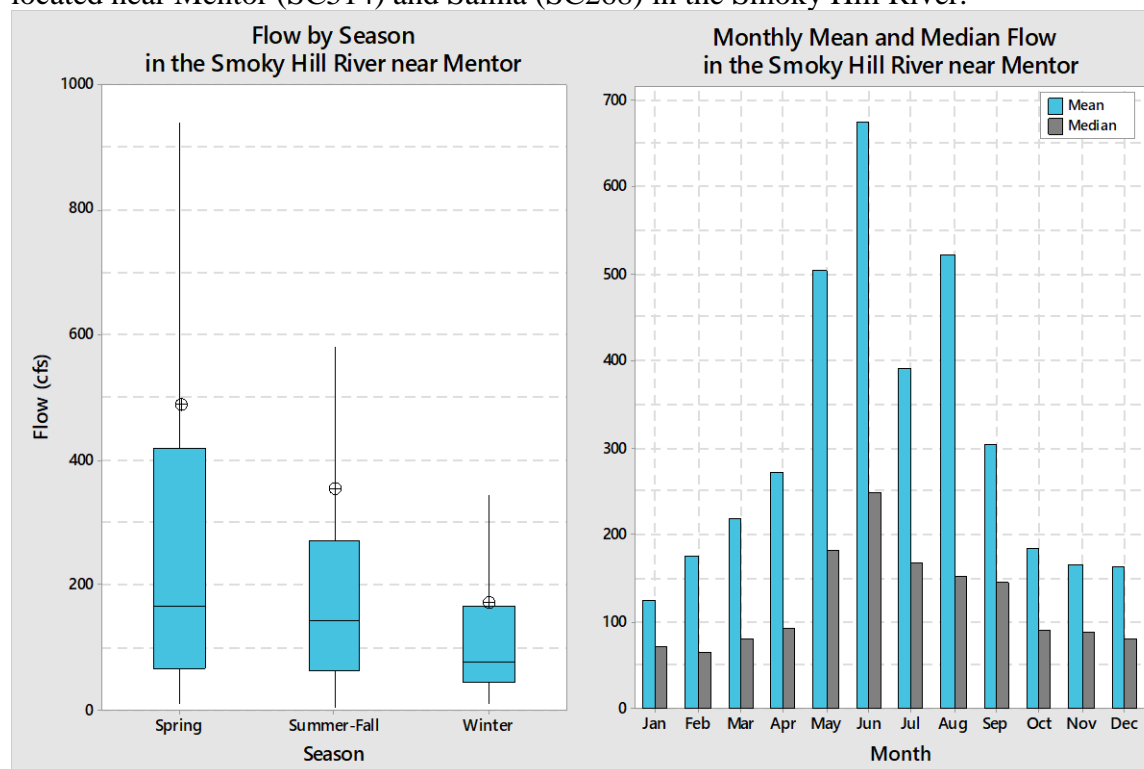


Figure 8. Flow by season and month for U.S. Geological Survey gage 06866500 at Mentor, located near Mentor (SC514) and Salina (SC268) in the Smoky Hill River.



The highest mean annual flows in the Smoky Hill River at Enterprise occurred in 1993, 1995, and 1998, with flows of: 8,802; 2,939; and 2,556 cfs, respectively (**Figure 9**). The highest median annual flows occurred in 1993, 1994, and 1998, with flows of: 6,290; 1,550; and 1,620 cfs, respectively. Annual mean and median flows were lowest in 1991 and 2006, with mean flows of 291 and 173 cfs, respectively, and median flows of 158 and 135 cfs, respectively. Trends in annual flows generally coincide with NOAA annual total precipitation from station USC00142574 in Enterprise. The highest annual precipitation in the Smoky Hill River at Enterprise occurred in 1993, 1995, and 1998, corresponding to the highest annual years of flow. The peak annual flows occurred in 1993, 1998, and 2007, with flows of: 46,200; 25,300; and 27,500 cfs, respectively (**Figure 10**). The range of peak annual flows is 1,400 cfs in 2002 to 46,200 cfs in 1993, with the second lowest peak annual flow of 2,010 cfs in 2006 corresponding to one of the years with the lowest mean and median flows.

Seasonally in the Smoky Hill River at Enterprise, the highest flows occur in spring and lowest flows occur in winter (**Figure 11**). Spring and summer-fall (July through October) flows are the most skewed by high flow events, likely due to precipitation and runoff events. These high flow events correspond to higher flows from May through August; meanwhile, winter low flows correspond to the months of December and January.

Figure 9. Annual mean and median flows for U.S. Geological Survey gage 06877600 at Enterprise in the Smoky Hill River, located at Enterprise (SC265), and annual total precipitation at National Oceanic and Atmospheric Association station USC00142574 in Enterprise.

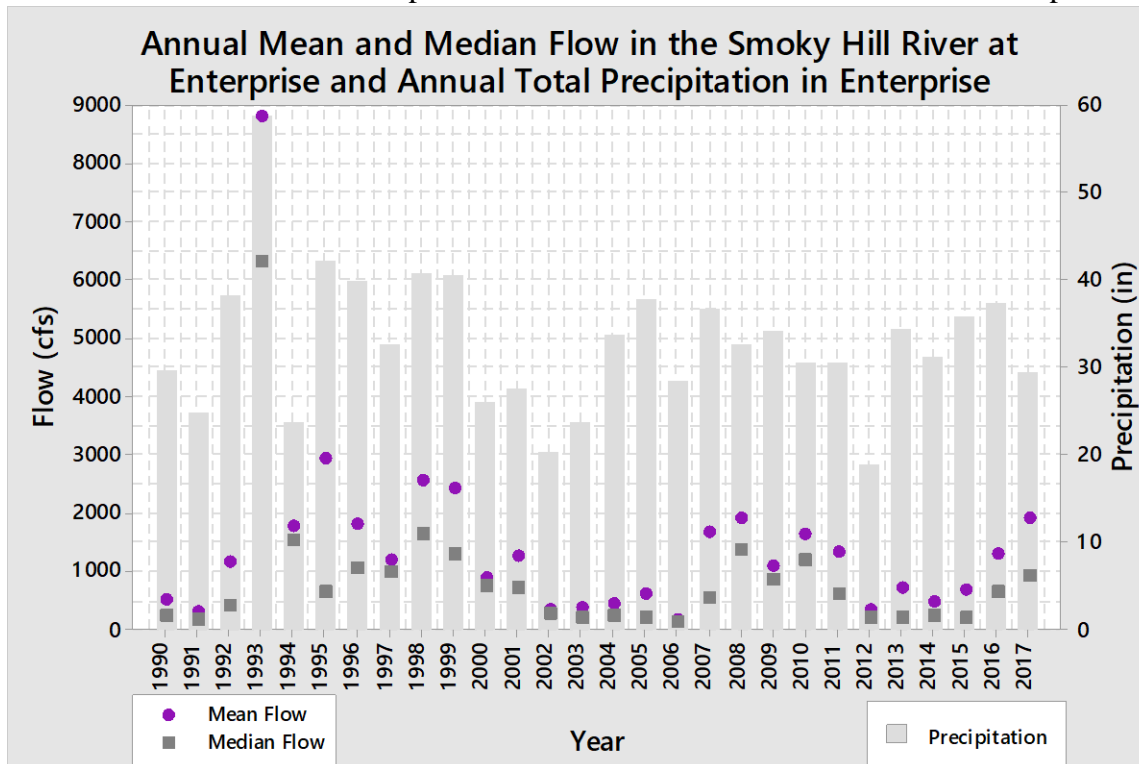


Figure 10. Annual peak flows for U.S. Geological Survey gage 06877600 at Enterprise, located at Enterprise (SC265) in the Smoky Hill River.

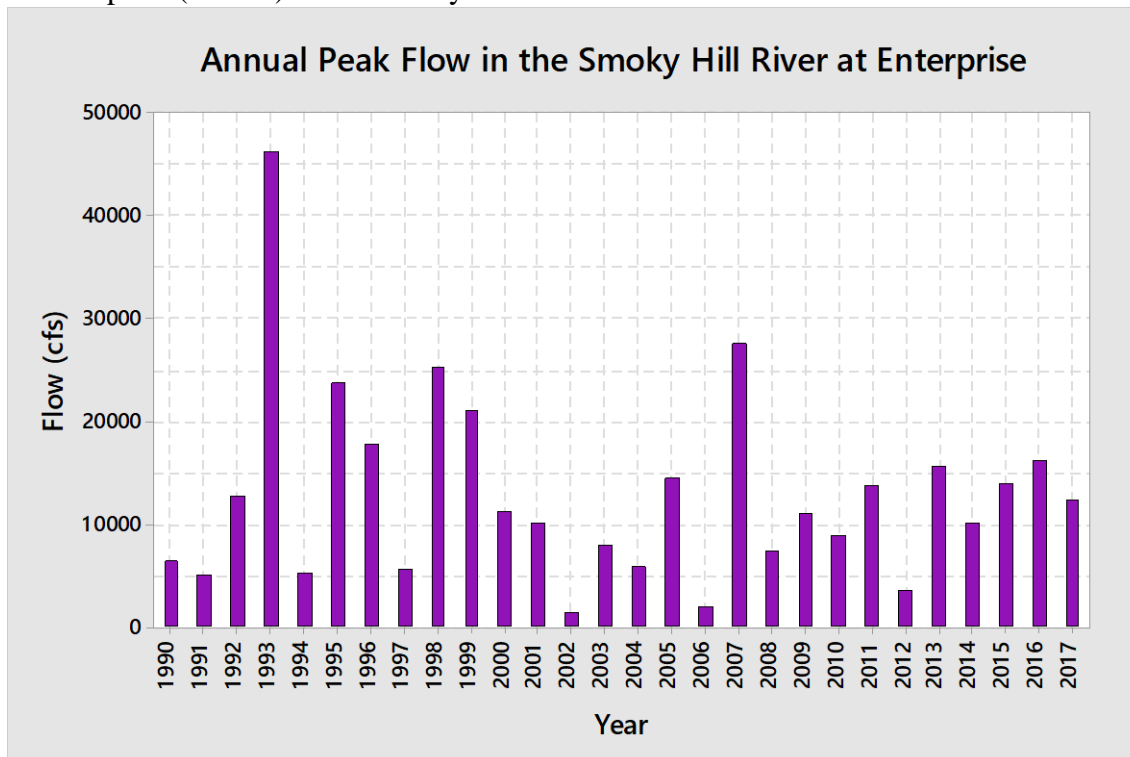
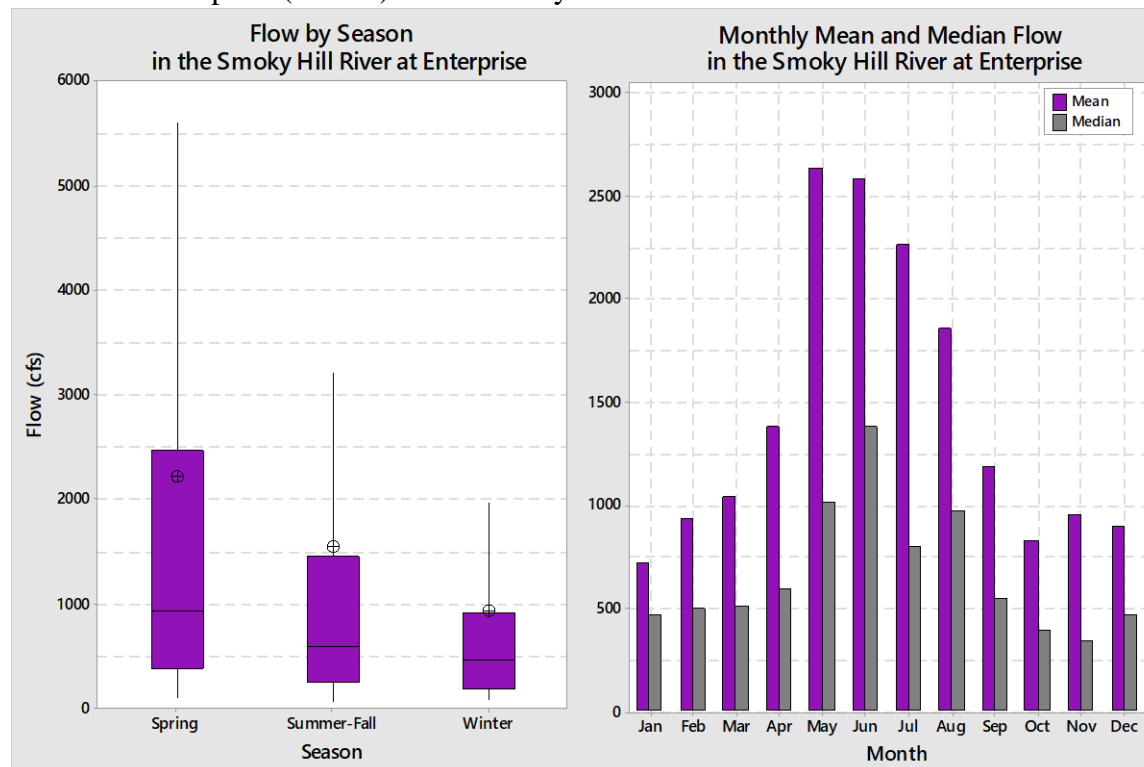


Figure 11. Flow by season and month for U.S. Geological Survey gage 06877600 at Enterprise, located at Enterprise (SC265) in the Smoky Hill River.



The highest mean annual flows in the Smoky Hill River at Junction City occurred in 1993, 1995, and 1998, with flows of: 9,845; 3,587; and 3,319 cfs, respectively (**Figure 12**). The highest median annual flows occurred in 1993, 1994, and 1998, with flows of: 7,210; 1,803; and 2,223 cfs, respectively. Annual mean and median flows were lowest in 1991 and 2006, with mean low flows of 351 and 255 cfs, respectively, and median low flows of 232 and 202 cfs, respectively. Trends in annual flows generally coincide with NOAA annual total precipitation at station USC00145306 at Milford Lake, Kansas. The highest annual precipitation occurred in 1993 and 1995, corresponding to years with the highest mean flow. The years with the lowest precipitation were 2000 and 2012.

Annual peak flows in the Smoky Hill River at Junction City occurred in 1993, 1995, and 1998, with highs of: 63,000; 30,430; and 29,720 cfs, respectively (**Figure 13**). The range of peak annual flows is 1,606 cfs in 2002 to 63,000 cfs in 1993, with the second lowest peak annual flow of 1,835 cfs in 2006 corresponding to one of the years with the lowest mean and median flows.

Seasonally in the Smoky Hill River at Junction City, high flows occur in spring and low flows occur in winter (**Figure 14**). Spring and summer-fall flows are more skewed by high flow events, corresponding to higher flows from May through August. Meanwhile, winter low flows correspond to the months of December and January.

Figure 12. Estimated annual mean and median flows at Junction City (SC264) in the Smoky Hill River, based upon U.S. Geological Survey gages 06857100 at Junction City in the Republican River and 06879100 at Fort Riley in the Kansas River, and annual total precipitation at National Oceanic and Atmospheric Association station USC00145306 at Milford Lake, Kansas.

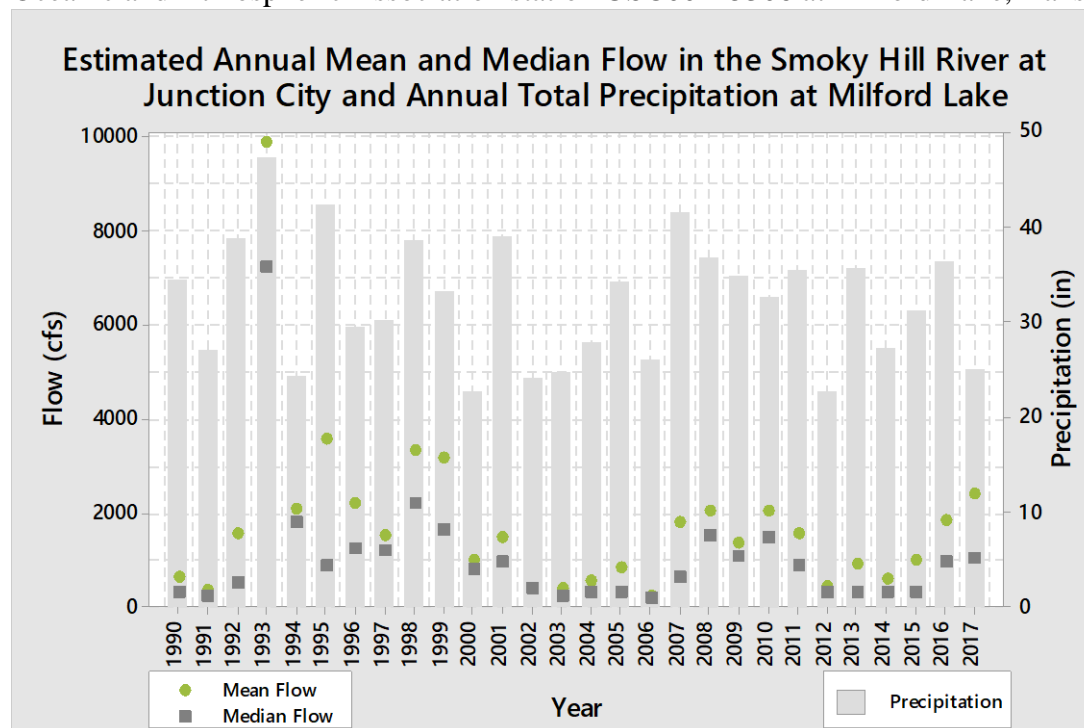


Figure 13. Estimated annual peak flows at Junction City (SC264) in the Smoky Hill River, based upon U.S. Geological Survey gages 06857100 at Junction City in the Republican River and 06879100 at Fort Riley in the Kansas River.

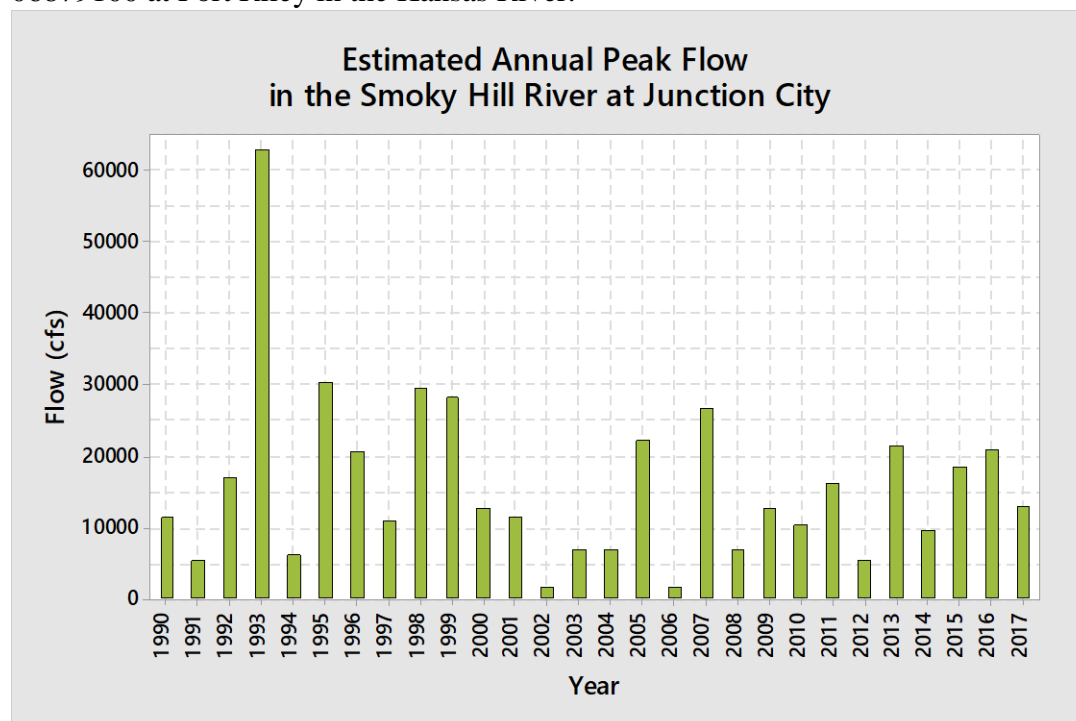
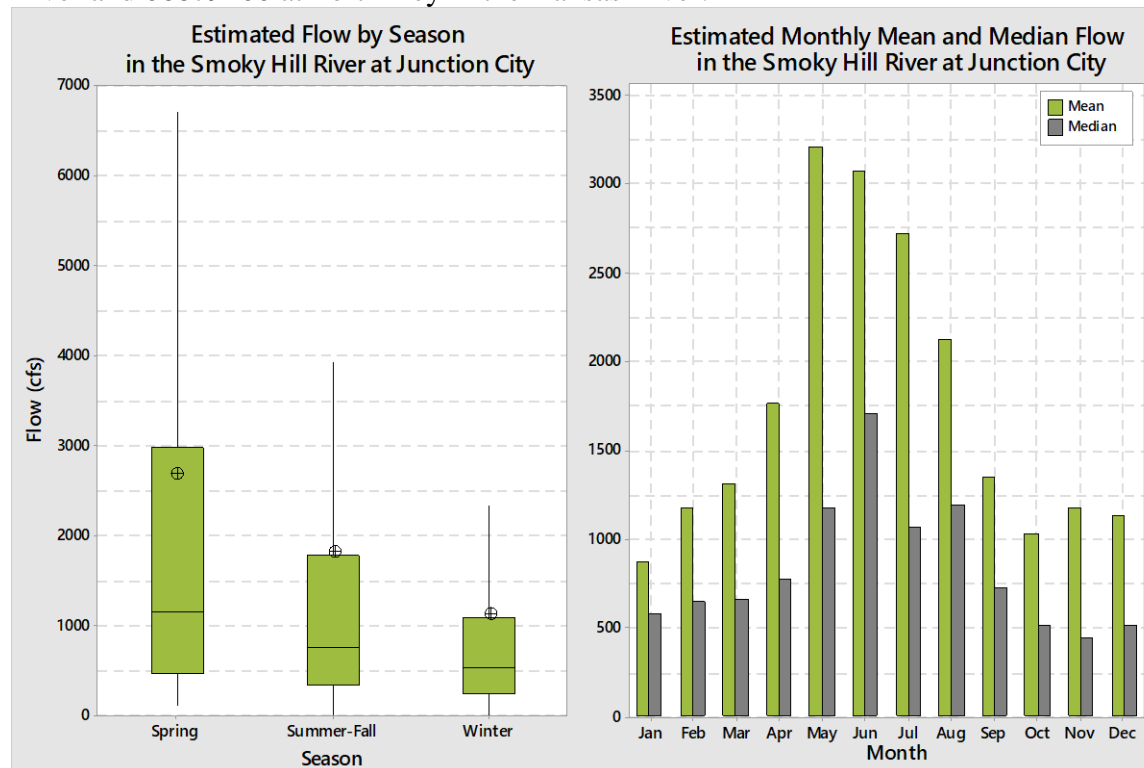


Figure 14. Estimated flow by season and month at Junction City (SC264) in the Smoky Hill River, based upon U.S. Geological Survey gages 06857100 at Junction City in the Republican River and 06879100 at Fort Riley in the Kansas River.



Total Phosphorus Concentrations

Overall, total phosphorus (TP) concentrations in the Smoky Hill River from Mentor to Junction City increase from the upstream, unimpaired Mentor (SC514) station to the downstream Junction City (SC264) station (**Figure 15**). The Mentor (SC514) station, while considered unimpaired for TP, is located on impaired stream segment CUSEGA 1026000813, which is monitored at its terminus near Salina (SC268); therefore, Mentor (SC514) is considered in this analysis for comparison purposes. Mean and median TP concentrations from Salina (SC268) to Junction City (SC264) are consistently more than twice the concentrations near Mentor (SC514), though mean and median TP concentrations at Enterprise (SC265) tend to decline slightly before increasing again at Junction City (SC264). Of all the stations, Salina (SC268) has the highest mean and median TP concentrations.

The range of TP concentrations is from 0.024 milligrams per liter (mg/L) at the upstream station near Mentor (SC514) to 5.160 mg/L at the station near Salina (SC268; **Table 4**). The TP concentration of 5.160 mg/L near Salina (SC268) is considerably higher than all other TP concentrations. This sample was collected in the early 1990s and is not considered representative of current (since 2000) TP concentrations near Salina (SC268). Among the stations, Mentor (SC514) and Enterprise (SC265) have the least variable means and medians: Mentor (SC514) has a mean of 0.183 mg/L and a median of 0.145 mg/L; Enterprise has a mean of 0.391 mg/L and a median of 0.319 mg/L. Meanwhile, Salina (SC268) and Junction City

(SC264) have the most variable means and medians: Salina (SC268) has a mean of 0.516 mg/L and a median of 0.362 mg/L; Junction City (SC264) has a mean of 0.458 mg/L and a median of 0.340 mg/L. It should be noted that Junction City (SC264) has the fewest number of samples due to the rotational collection of data at this station.

Figure 15. Total phosphorus by station from 1990 to 2017 in the Smoky Hill River from Mentor to Junction City.

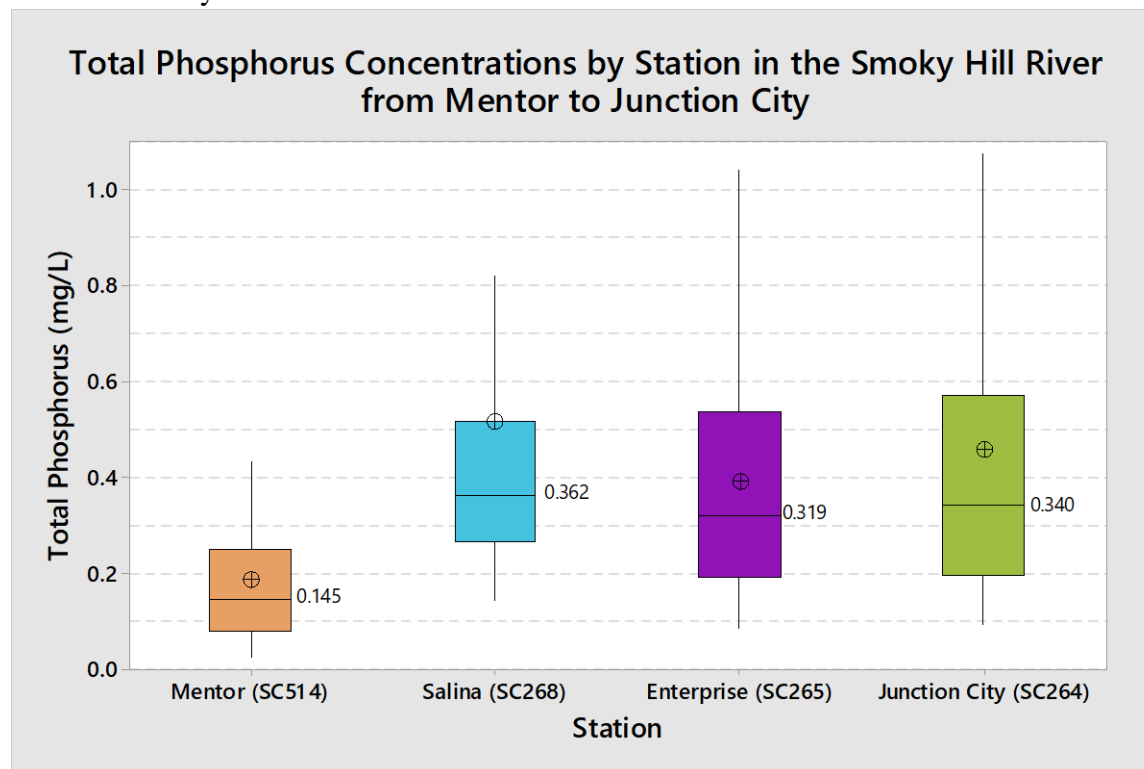


Table 4. Total phosphorus concentration mean, median, maximum, minimum, and number of samples (N) by station from 1990 to 2017 in the Smoky Hill River from Mentor to Junction City.

Station	Mean	Median	Maximum	Minimum	N
Mentor (SC514)	0.183	0.145	0.804	0.024	144
Salina (SC268)	0.516	0.362	5.160	0.140	144
Enterprise (SC265)	0.391	0.319	1.270	0.080	148
Junction City (SC264)	0.458	0.340	1.690	0.089	96

Annually, the highest mean TP concentrations occurred in: 2004 near Mentor (SC514), with a mean of 0.291 mg/L; 1992 near Salina (SC268), with a mean of 1.513 mg/L; 2007 at Enterprise (SC265), with a mean of 0.615 mg/L; and 2007 at Junction City (SC264), with a mean of 0.684 mg/L (**Figures 16-19; Table 5**). The high mean near Salina (SC268) in 1992 is strongly influenced by an exceptionally high TP concentration of 5.160 mg/L during this sampling year, and this value is considered an outlier of the samples collected at Salina (SC268); while the concentration is included in this analysis, it is not displayed in **Figure 17**. The highest mean TP concentration at Enterprise (SC265) corresponds to one of the years with the highest peak flow

conditions, indicating that this station may be more strongly influenced by TP loading during precipitation events. The highest median TP concentrations occurred in: 1993 near Mentor (SC514), with a median of 0.270 mg/L; 2012 near Salina (SC268), with a median of 1.040 mg/L; 2005 at Enterprise (SC265), with a median of 0.562 mg/L; and 2007 at Junction City (SC264), with a median of 0.607 mg/L. The highest median TP concentration near Mentor (SC514) also corresponds to a high flow year, indicating that this station may be more strongly influenced by TP loading during precipitation events. Meanwhile, the highest median TP concentration near Salina (SC268) corresponds to a low flow year, indicating that this station may be more strongly influenced by municipal point sources.

Annually, the lowest mean TP concentrations occurred in: 2006 near Mentor (SC514), with a mean of 0.080 mg/L; 1996 near Salina (SC268), with a mean of 0.262 mg/L; 2000 at Enterprise (SC265), with a mean of 0.190 mg/L; and 2014 at Junction City (SC264), with a mean of 0.324 mg/L. The lowest mean TP concentration near Mentor (SC514) corresponds to a low flow year, reinforcing that this station is more strongly influenced by streamflow and likely more impacted by nonpoint source loads of TP. The lowest median TP concentrations occurred in: 2015 near Mentor (SC514), with a median of 0.068 mg/L; 2009 near Salina (SC268), with a median of 0.233 mg/L; 2017 at Enterprise (SC265), with a median of 0.160 mg/L; and 2014 at Junction City (SC264), with a median of 0.265 mg/L.

Figure 16. Total phosphorus by sampling date and annual mean and median total phosphorus near Mentor (SC514) in the Smoky Hill River.

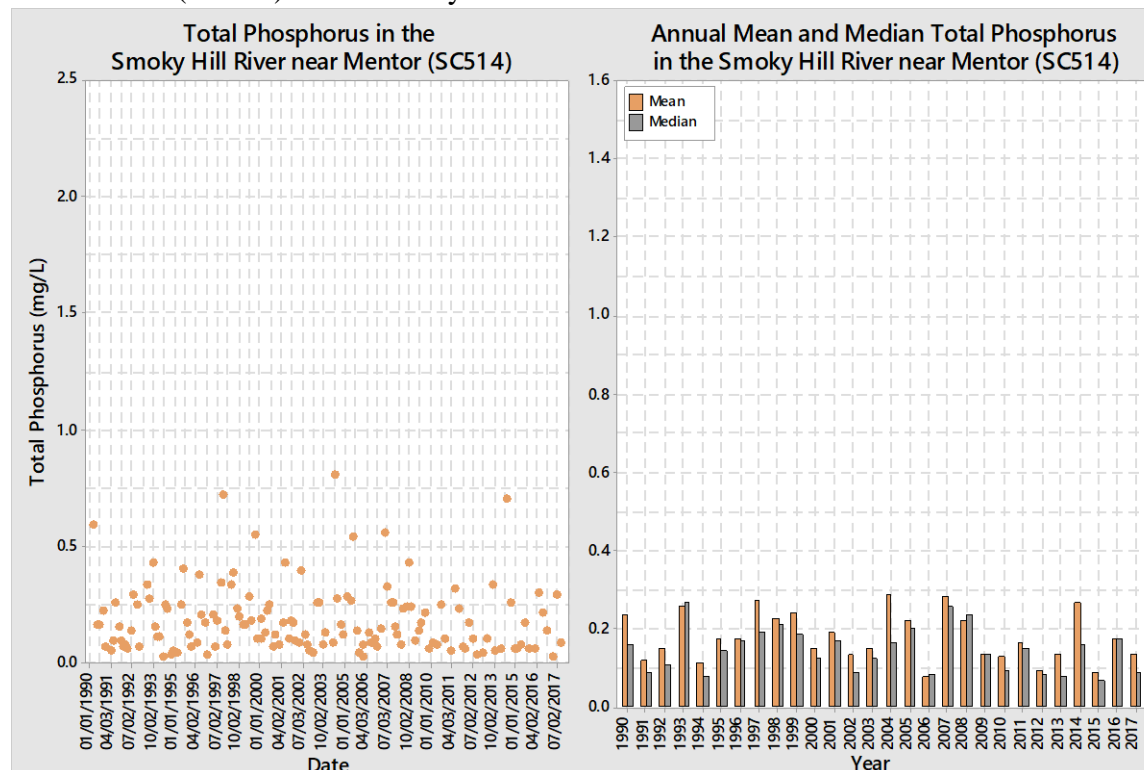


Figure 17. Total phosphorus by sampling date and annual mean and median total phosphorus near Salina (SC268) in the Smoky Hill River.

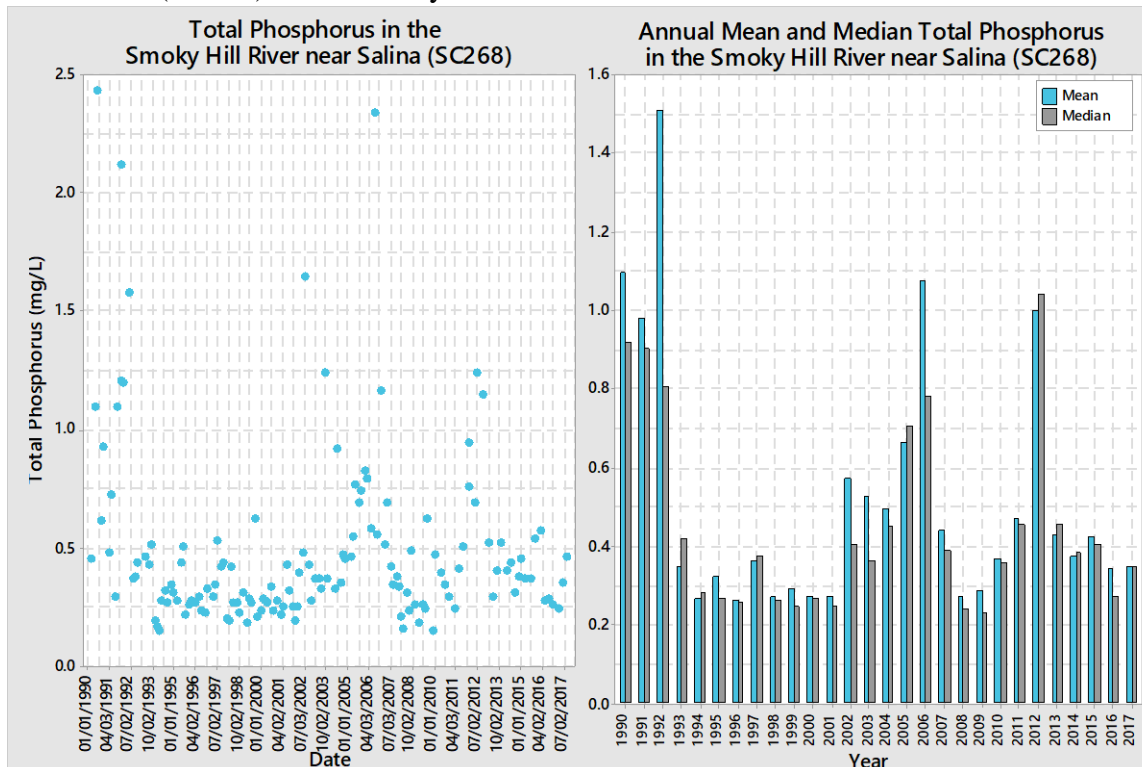


Figure 18. Total phosphorus by sampling date and annual mean and median total phosphorus at Enterprise (SC265) in the Smoky Hill River.

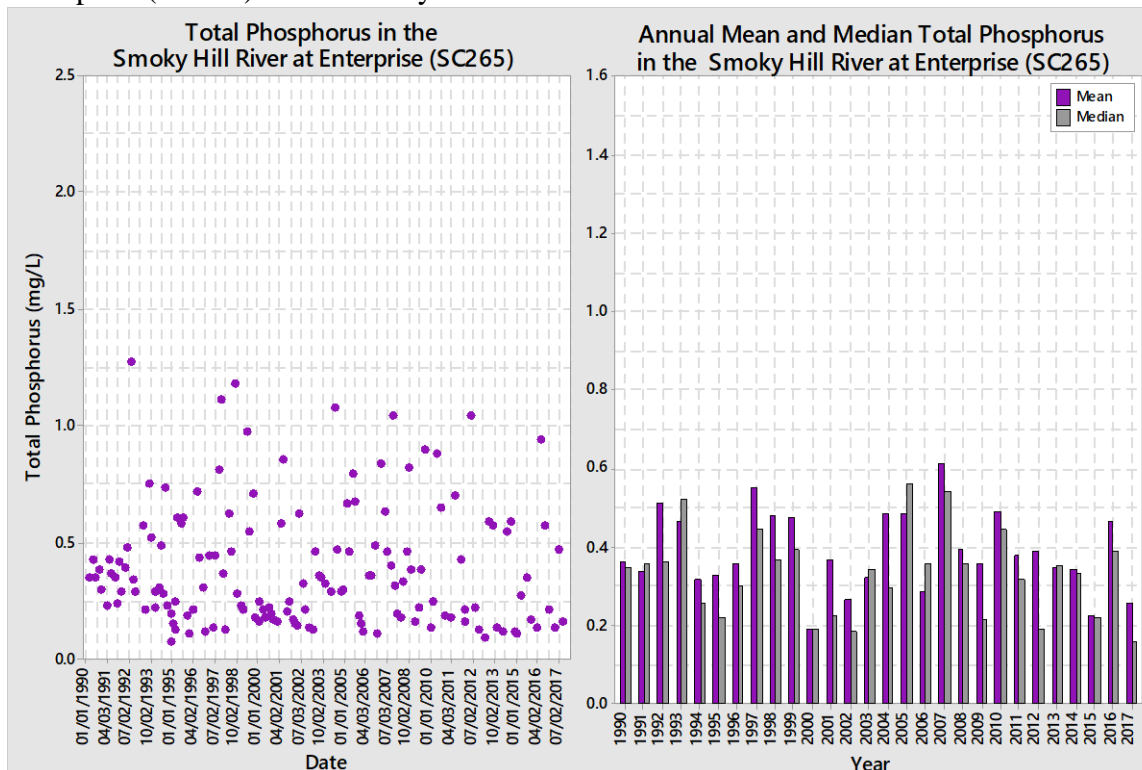


Figure 19. Total phosphorus by sampling date and annual mean and median total phosphorus at Junction City (SC264) in the Smoky Hill River.

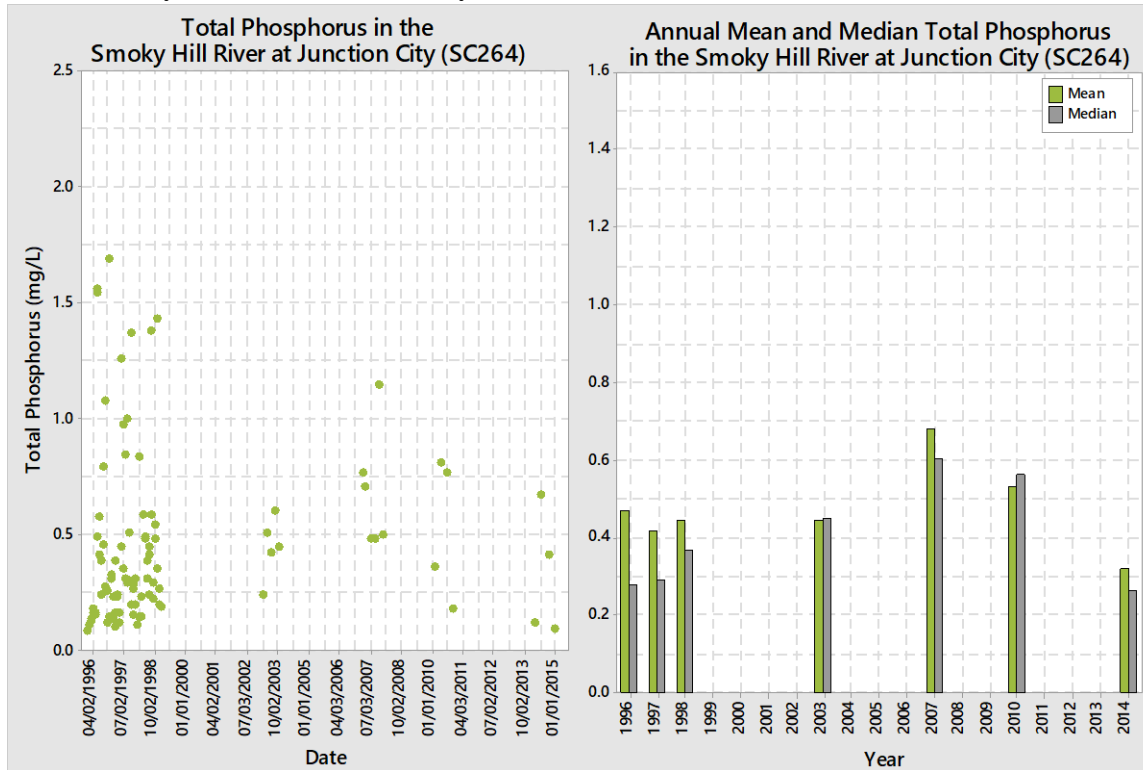


Table 5. Total phosphorus concentration annual mean, median, and sample number (N) by station in the Smoky Hill River from Mentor to Junction City.

Year	Mentor (SC514)			Salina (SC268)			Enterprise (SC265)			Junction City (SC264)		
	Mean	Median	N	Mean	Median	N	Mean	Median	N	Mean	Median	N
1990	0.240	0.160	5	1.098	0.920	5	0.362	0.350	5	—	—	—
1991	0.118	0.090	6	0.980	0.905	6	0.340	0.360	6	—	—	—
1992	0.148	0.110	6	1.513	0.810	6	0.510	0.365	6	—	—	—
1993	0.258	0.270	5	0.348	0.420	5	0.468	0.520	5	—	—	—
1994	0.116	0.080	6	0.270	0.285	6	0.318	0.255	8	—	—	—
1995	0.175	0.145	6	0.322	0.269	6	0.328	0.220	8	—	—	—
1996	0.175	0.170	5	0.262	0.259	5	0.358	0.305	5	0.472	0.280	25
1997	0.276	0.191	6	0.365	0.376	6	0.551	0.444	6	0.418	0.289	26
1998	0.229	0.213	6	0.274	0.263	6	0.483	0.371	6	0.445	0.370	26
1999	0.243	0.185	6	0.295	0.245	6	0.477	0.396	6	—	—	—
2000	0.148	0.125	6	0.273	0.270	6	0.190	0.190	6	—	—	—
2001	0.190	0.174	6	0.270	0.247	6	0.369	0.226	6	—	—	—
2002	0.138	0.090	6	0.571	0.403	6	0.265	0.187	6	—	—	—
2003	0.150	0.125	5	0.528	0.362	5	0.324	0.346	5	0.444	0.449	5
2004	0.291	0.166	5	0.498	0.451	5	0.485	0.300	5	—	—	—

Year	Mentor (SC514)			Salina (SC268)			Enterprise (SC265)			Junction City (SC264)		
	Mean	Median	N	Mean	Median	N	Mean	Median	N	Mean	Median	N
2005	0.225	0.202	6	0.664	0.707	6	0.488	0.562	6	—	—	—
2006	0.080	0.083	5	1.078	0.782	5	0.287	0.357	5	—	—	—
2007	0.283	0.259	6	0.441	0.390	6	0.615	0.544	6	0.684	0.607	6
2008	0.224	0.237	6	0.271	0.243	6	0.396	0.357	6	—	—	—
2009	0.136	0.137	5	0.286	0.233	5	0.361	0.218	5	—	—	—
2010	0.130	0.095	4	0.368	0.360	4	0.490	0.448	4	0.530	0.565	4
2011	0.168	0.149	4	0.473	0.454	4	0.380	0.318	4	—	—	—
2012	0.094	0.085	4	0.999	1.040	4	0.389	0.191	4	—	—	—
2013	0.134	0.079	4	0.431	0.457	4	0.350	0.354	4	—	—	—
2014	0.270	0.160	4	0.375	0.385	4	0.345	0.335	4	0.324	0.265	4
2015	0.091	0.068	4	0.425	0.405	4	0.225	0.220	4	—	—	—
2016	0.177	0.175	4	0.343	0.275	4	0.465	0.390	4	—	—	—
2017	0.136	0.089	3	0.350	0.350	3	0.257	0.160	3	—	—	—
1990-1999	0.198	0.165	57	0.573	0.331	57	0.419	0.363	61	0.445	0.289	77
2000-2017	0.170	0.131	87	0.480	0.387	87	0.371	0.327	87	0.496	0.507	19

Definition: — no data

Individual TP samples collected on concurrent days indicate a similar trend, when comparing upstream and downstream samples. Samples collected near upstream Mentor (SC514) and downstream Salina (SC268) indicate that higher TP concentrations are detected near Salina (SC268; **Figure 20**). Samples collected near upstream Salina (SC268) and at downstream Enterprise (SC265) again indicate that higher TP concentrations are detected near Salina (SC268); however, TP concentrations are more variable at Enterprise (SC265) and higher TP concentrations do occur at Enterprise (SC265) when TP concentrations are lower at Salina (SC268; **Figure 21**). These TP concentrations at Enterprise (SC265) may be partially attributable to TP sources from larger tributaries, such as the Saline River and Solomon River, in this portion of the watershed. Similar to Salina (SC268), samples collected at upstream Enterprise (SC265) and downstream Junction City (SC264) indicate that TP concentrations increase at Junction City (SC264), though TP concentrations are consistently higher at both stations (**Figure 22**).

Figure 20. Total phosphorus at upstream Mentor (SC514) versus downstream Salina (SC268) for concurrent day samples in the Smoky Hill River, March 14, 1990 to September 11, 2017.

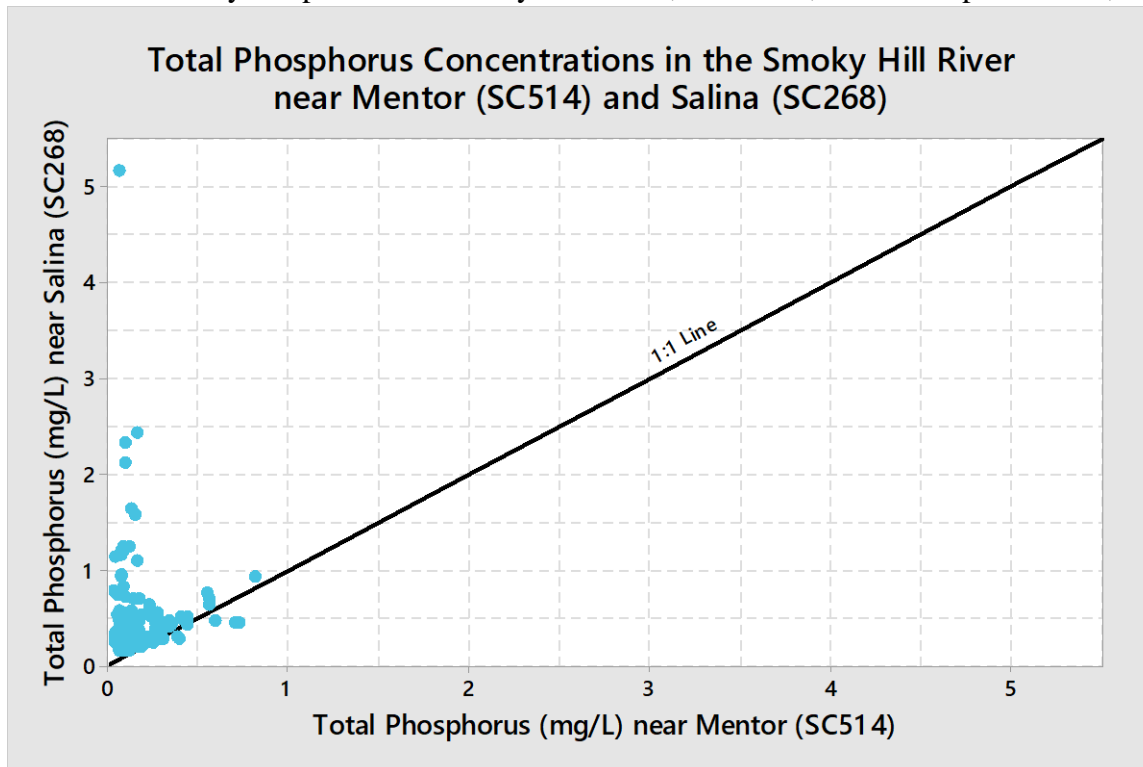


Figure 21. Total phosphorus at upstream Salina (SC268) versus downstream Enterprise (SC265) for concurrent day samples in the Smoky Hill River, March 14, 1990 to September 11, 2017.

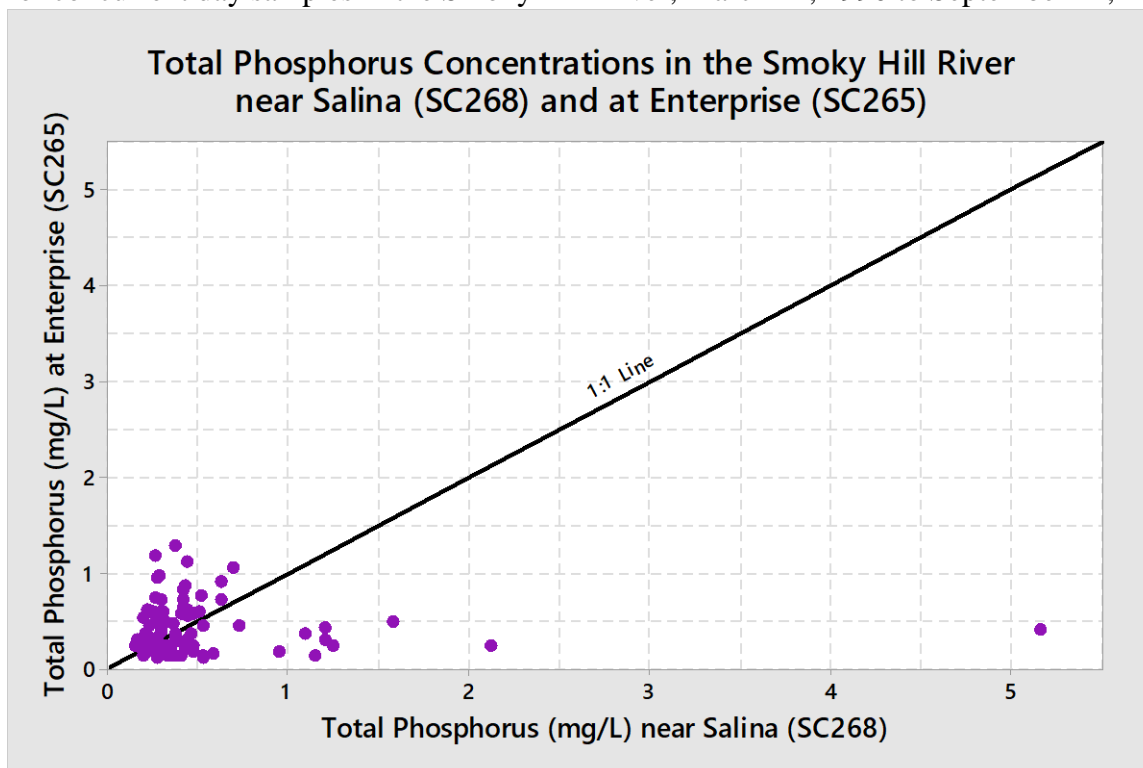
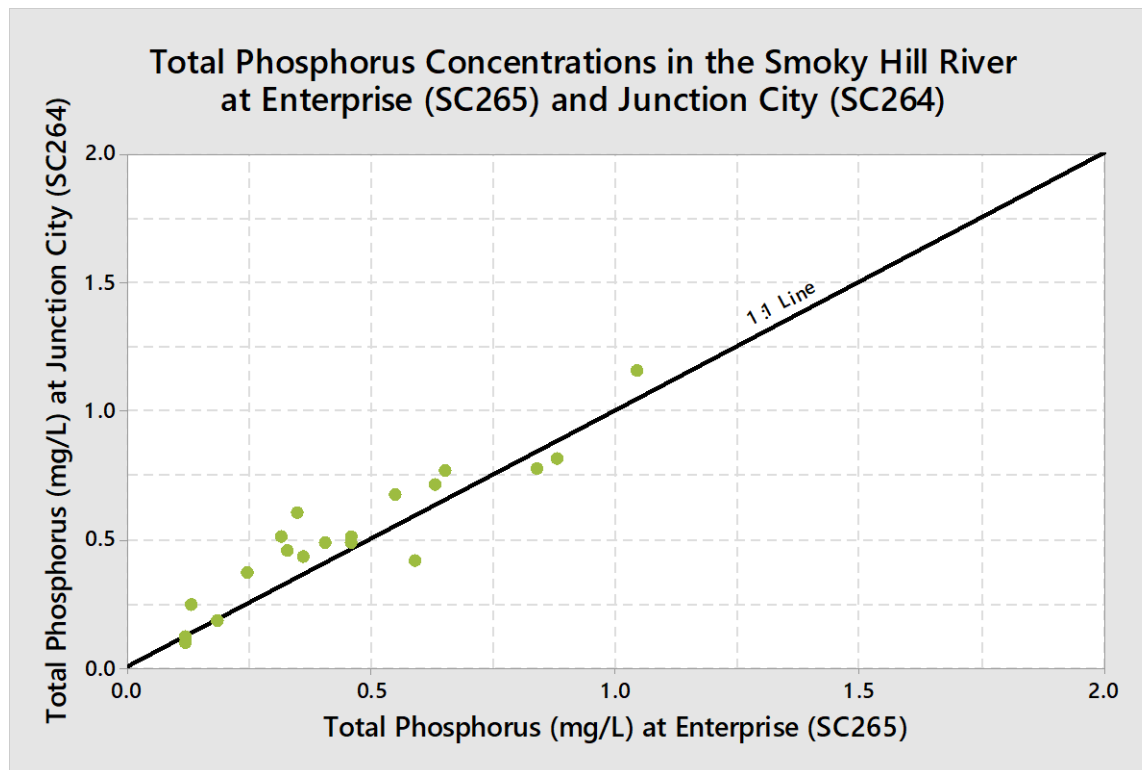


Figure 22. Total phosphorus at upstream Enterprise (SC265) versus downstream Junction City (SC264) for concurrent day samples in the Smoky Hill River, February 19, 2003 to December 8, 2014.



In general, TP concentrations in the Smoky Hill River from Mentor to Junction City are higher during high flow conditions (0-25%; **Figure 23**). For example, Mentor (SC514) has mean and median TP concentrations of 0.291 and 0.258 mg/L, respectively, during high flow conditions (**Table 6**). These concentrations are approximately three times lower during low flow conditions (76-100%), declining to a mean and median of 0.088 and 0.080 mg/L, respectively. Enterprise (SC265) exhibits a similar trend to Mentor (SC514), though with higher TP concentrations that are approximately two times lower during low flow conditions. Higher TP concentrations during high flow conditions, such as those seen at Mentor (SC514) and Enterprise (SC265), can be indicative of nonpoint sources and stormwater runoff. While Junction City (SC264) also exhibits higher TP concentrations during high flow conditions, TP concentrations at this station do not continue to decline during low flow conditions. Instead, TP concentrations during low flow conditions increase above concentrations seen at normal flow conditions (26-75%). Of the four stations, Salina (SC268) is the most notable exception, with TP concentrations steadily increasing from high to low flow conditions. At low flow conditions, Salina (SC268) has TP concentrations more than three times TP concentrations at high flow conditions. Increases in TP concentrations at low flow conditions, such as those seen at Junction City (SC264) and Salina (SC268), indicating the influence of municipal point source TP loading in the stream.

Figure 23. Total phosphorus by percent flow exceedance and station in the Smoky Hill River from Mentor to Junction City.

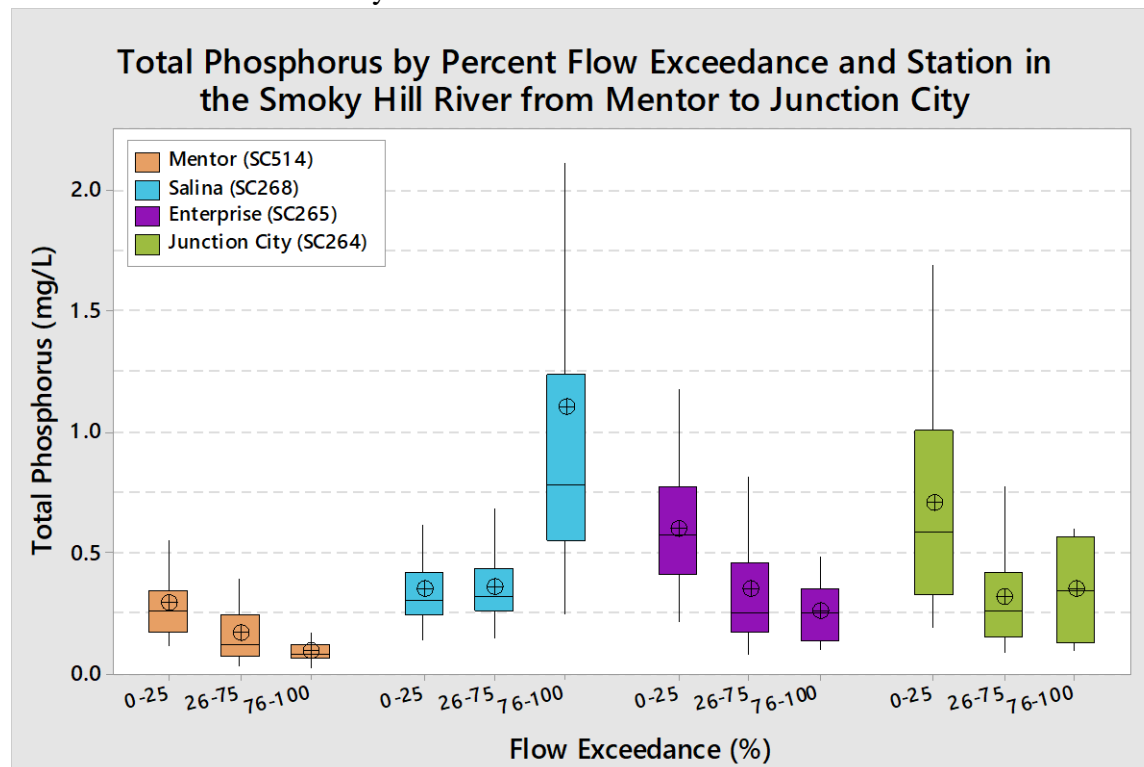


Table 6. Total phosphorus concentration mean, median, and number of samples (N) by season (spring: April through June, summer-fall: July through October, winter: November through March), flow range, and station in the Smoky Hill River from Mentor to Junction City.

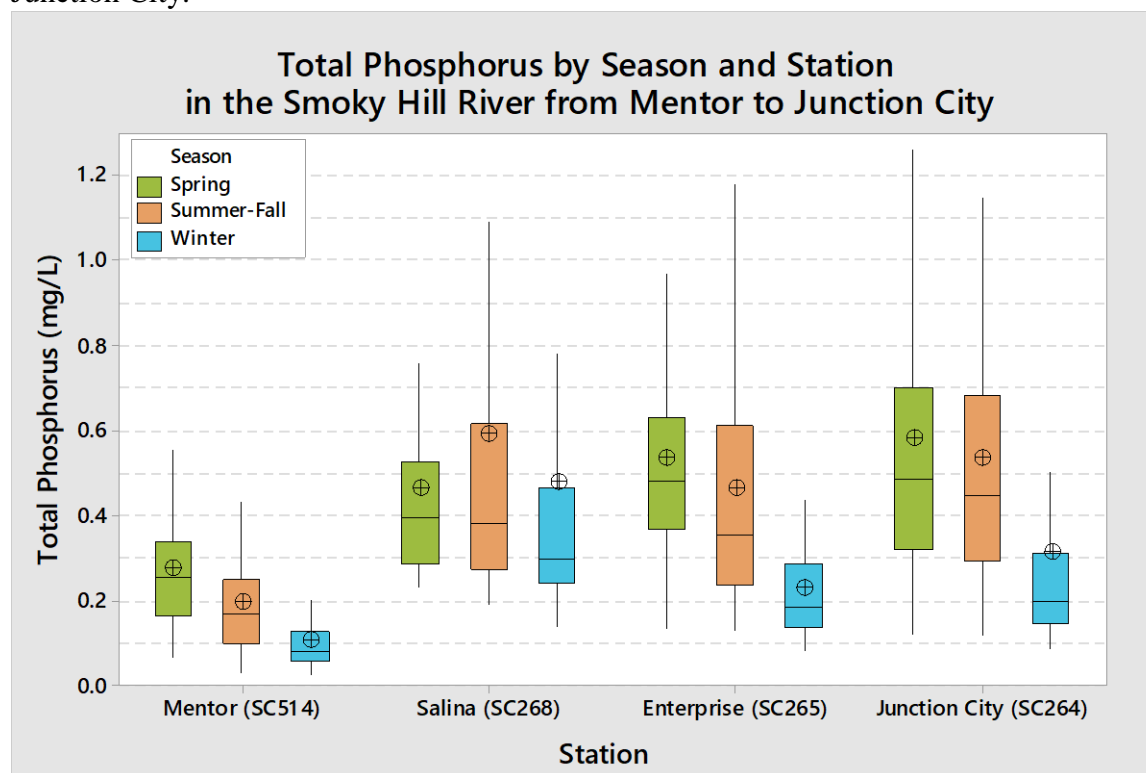
Flow Exceedance (%)	Spring			Summer-Fall			Winter			All		
	Mean	Median	N	Mean	Median	N	Mean	Median	N	Mean	Median	N
<i>Mentor (SC514)</i>												
0-25	0.345	0.319	15	0.341	0.297	12	0.173	0.160	12	0.291	0.258	39
26-75	0.274	0.254	17	0.176	0.191	26	0.100	0.077	31	0.167	0.123	74
76-100	0.117	0.114	6	0.097	0.097	12	0.065	0.064	13	0.088	0.080	31
0-100	0.277	0.254	38	0.197	0.172	50	0.107	0.080	56	0.183	0.145	144
<i>Salina (SC268)</i>												
0-25	0.417	0.408	15	0.380	0.385	12	0.240	0.243	12	0.351	0.302	39
26-75	0.425	0.362	17	0.363	0.332	26	0.316	0.285	31	0.357	0.320	74
76-100	0.700	0.629	6	1.307	1.187	12	1.095	0.782	13	1.101	0.782	31
0-100	0.465	0.397	38	0.594	0.385	50	0.480	0.300	56	0.516	0.362	144
<i>Enterprise (SC265)</i>												
0-25	0.599	0.570	15	0.761	0.720	12	0.391	0.338	10	0.595	0.574	37
26-75	0.521	0.458	20	0.431	0.365	24	0.199	0.170	35	0.351	0.250	79
76-100	0.385	0.395	4	0.272	0.295	14	0.195	0.134	14	0.253	0.255	32
0-100	0.537	0.480	39	0.466	0.354	50	0.231	0.184	59	0.391	0.319	148

Flow Exceedance (%)	Spring			Summer-Fall			Winter			All		
	Mean	Median	N	Mean	Median	N	Mean	Median	N	Mean	Median	N
<i>Junction City (SC264)</i>												
0-25	0.763	0.581	10	0.901	0.842	11	0.514	0.311	14	0.707	0.582	35
26-75	0.449	0.391	14	0.337	0.306	20	0.209	0.152	23	0.313	0.260	57
76-100	—	—	—	0.526	0.526	2	0.167	0.167	2	0.346	0.344	4
0-100	0.580	0.486	24	0.537	0.449	33	0.316	0.200	39	0.458	0.340	96

Definition: — no data

Seasonally, spring and summer-fall have greater TP means and medians than winter for all stations except Salina (SC268), which has a winter mean greater than the spring mean (**Table 6; Figure 24**). Mentor (SC514), Enterprise (SC265), and Junction City (SC264) have TP concentrations that decline from spring to winter.

Figure 24. Total phosphorus by season and station in the Smoky Hill River from Mentor to Junction City.



Additionally, Enterprise (SC265) and Junction City (SC264) maintain similar TP concentration means and medians during the spring and summer-fall. Mean concentrations during spring and summer-fall at Enterprise (SC265) are 0.537 and 0.466 mg/L and at Junction City (SC264) are 0.580 and 0.537 mg/L, respectively. Median concentrations during spring and summer-fall at Enterprise (SC265) are 0.480 and 0.354 mg/L and at Junction City (SC264) are 0.486 and 0.449 mg/L, respectively. Salina (SC268) exhibits a similar pattern throughout all seasons, with median TP

concentrations of 0.397, 0.385, and 0.300 mg/L in the spring, summer-fall, and winter, respectively. However, Salina (SC268) is the only station with mean summer-fall and winter TP concentrations that exceed spring TP concentrations, with means of 0.594, 0.480, and 0.465 mg/L, respectively. Higher TP concentrations during low flow conditions, which can occur in summer-fall and are typical of winter, are an additional indication of municipal point source TP influences in the watershed.

The influence of sources in the Smoky Hill River are also evident in individual stream samples through the variability in TP concentration magnitude and seasonal distribution across the range of percent flow exceedances (**Figures 25-28**). The station near Mentor (SC514) displays a trend of decreasing TP concentrations as flow decreases (**Figure 25**). Usually, TP concentrations over 0.25 mg/L occur in spring and summer-fall during higher flow conditions, likely corresponding to runoff due to precipitation. Meanwhile, TP concentrations remain below 0.25 mg/L during low flow conditions across all seasons. The trend displayed at Mentor (SC514), with TP concentrations increasing as flow increases, is typical of a station influenced by nonpoint sources. Meanwhile, TP concentrations near Salina (SC268) increase as flow decreases (**Figure 26**; outlier 5.160 mg/L not displayed). The highest TP concentrations are seen in summer-fall and winter during the lowest streamflow. The trend displayed at Salina (SC268), with TP concentrations increasing as flow decreases, is indicative of a station influenced by municipal point sources.

Figure 25. Total phosphorus by percent flow exceedance and season near Mentor (SC514) in the Smoky Hill River.

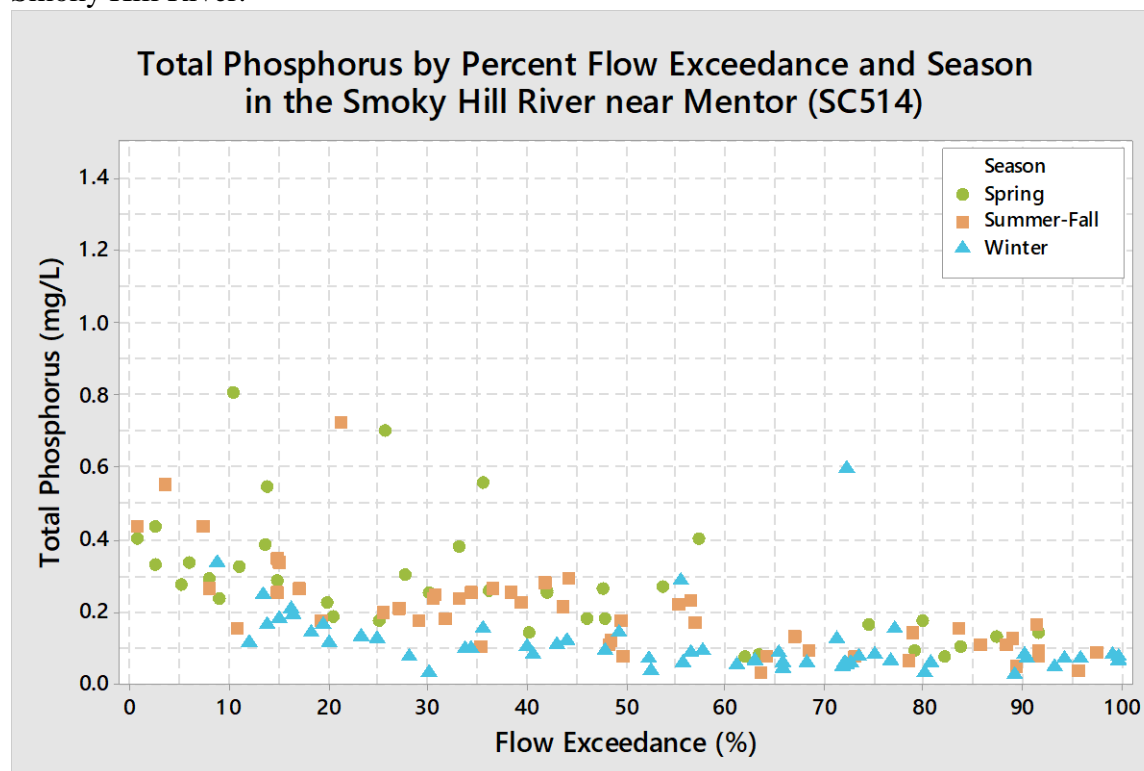
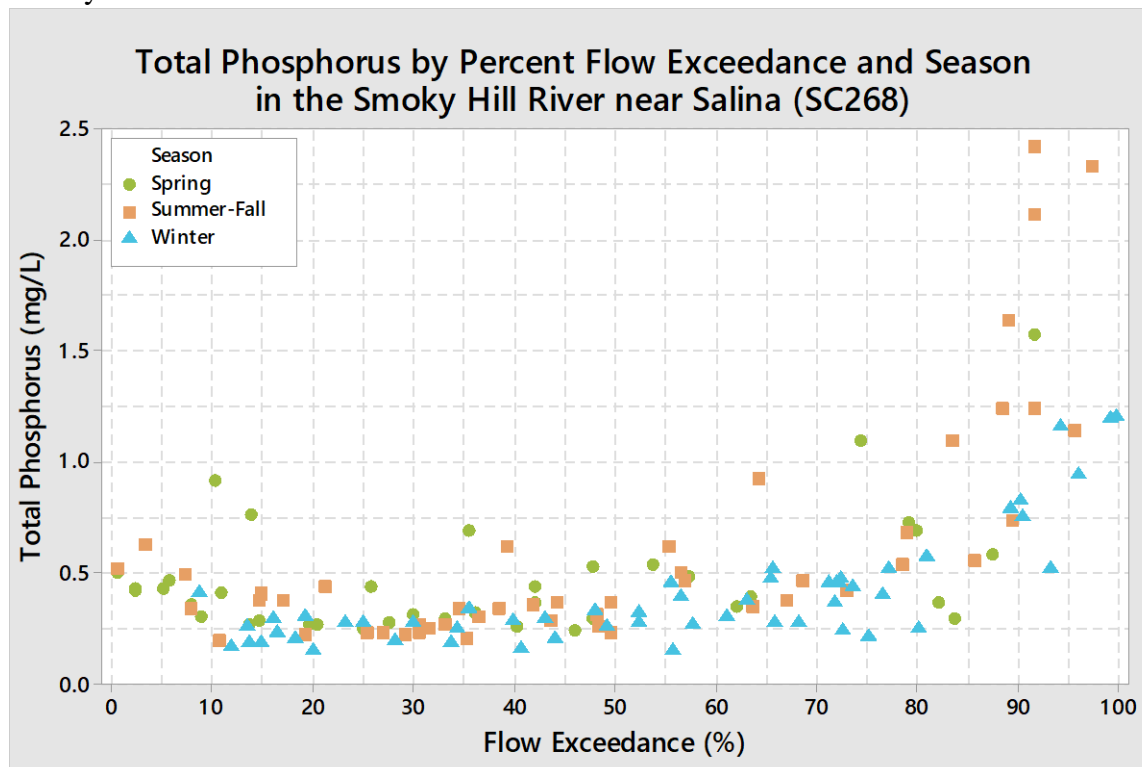


Figure 26. Total phosphorus by percent flow exceedance and season near Salina (SC268) in the Smoky Hill River.



Similar to Mentor (SC514), Enterprise (SC265) displays a trend of decreasing TP concentrations as streamflow decreases (**Figure 27**). Seasonally, samples are more variable at this site, but some stratification does occur, with high flow, high TP concentration samples primarily collected during spring and summer-fall. The station at Junction City (SC264) is more variable than the other three stations (**Figure 28**). As streamflow increases, high TP concentrations are detected throughout all seasons. Although there are a limited number of samples collected under low flow conditions at Junction City (SC264), available data suggests that TP concentrations may increase during low flow conditions in summer-fall.

Figure 27. Total phosphorus by percent flow exceedance and season at Enterprise (SC265) in the Smoky Hill River.

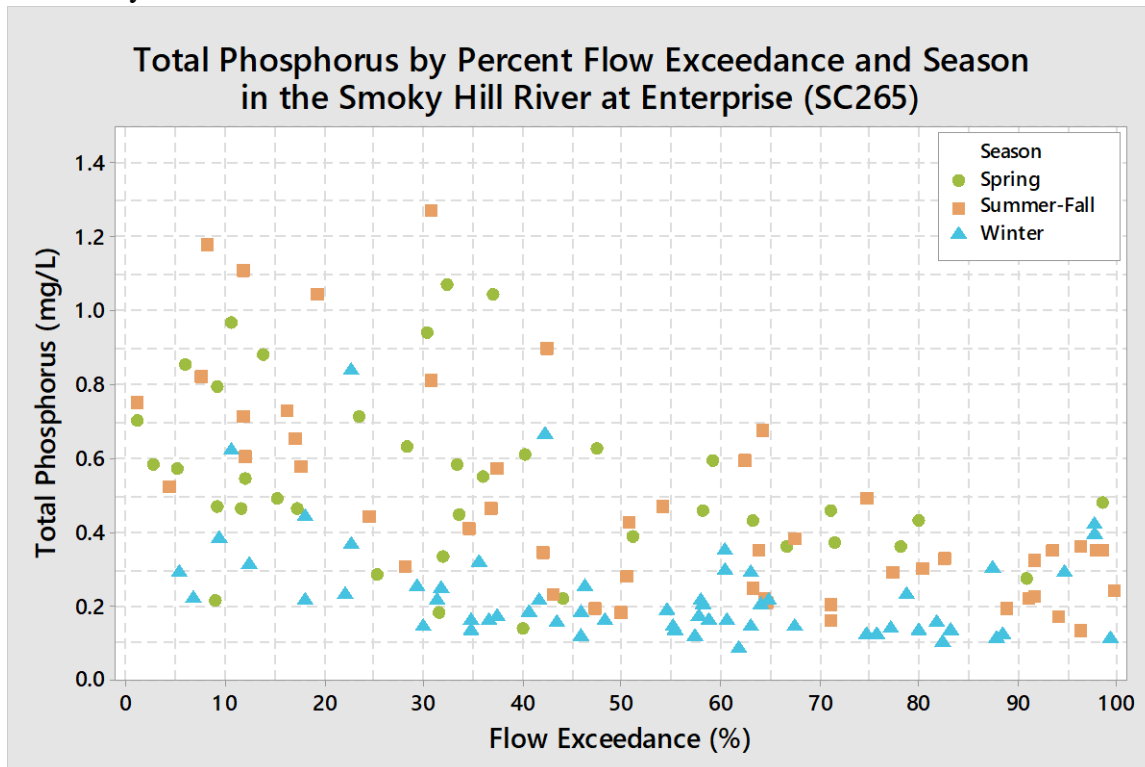
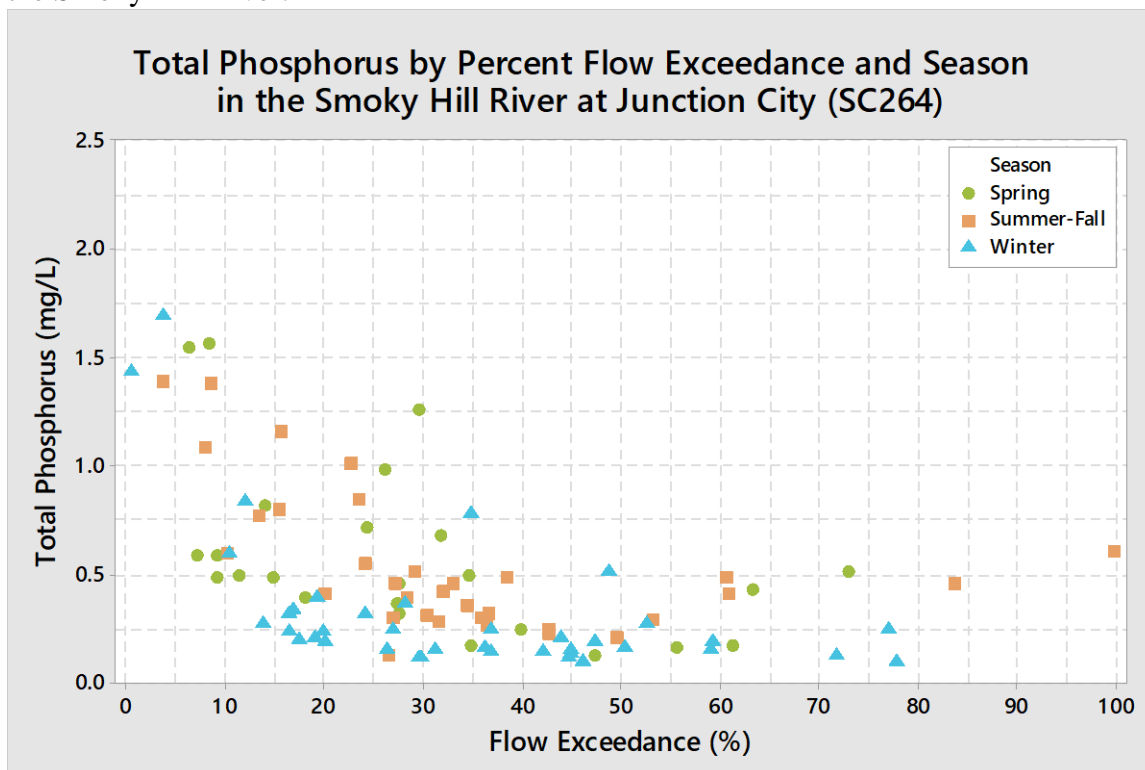


Figure 28. Total phosphorus by percent flow exceedance and season at Junction City (SC264) in the Smoky Hill River.



Total Phosphorus and Other Water Quality Parameters

Total phosphorus has well-established and defined relationships with orthophosphate (OP) and total suspended solids (TSS). These relationships are examined further in order to delineate potential sources of TP loading to the Smoky Hill River from Mentor to Junction City. The previous analysis noted that the TP concentration of 5.160 mg/L near Salina (SC268) is considerably higher than all other TP concentrations. As this sample is not considered representative of current TP concentrations near Salina (SC268), it has been excluded from the following analyses.

Orthophosphate

The soluble portion of TP that is readily available for biological use is OP. It is commonly found in higher concentrations in the discharge of municipal wastewater treatment plants (WWTPs), and can therefore be indicative of point source contributions of phosphorus in streams. Only samples measuring above the reporting limit are included in the analysis presented, resulting in a left censored data set which may overestimate true OP concentration means (**Table 7**). In addition, reporting limits for OP have changed throughout the period of record: 0.01 mg/L from 1995-1996, 0.02 mg/L from 1997 to February 2002, and 0.25 mg/L from March 2002 to 2014. Despite these variabilities, Salina (SC268) and Junction City (SC264) have consistently maintained the highest percentage of OP samples detected above the reporting limit, recording the highest censored mean OP concentrations throughout the overall period of record of 0.382 and 0.098 mg/L, respectively.

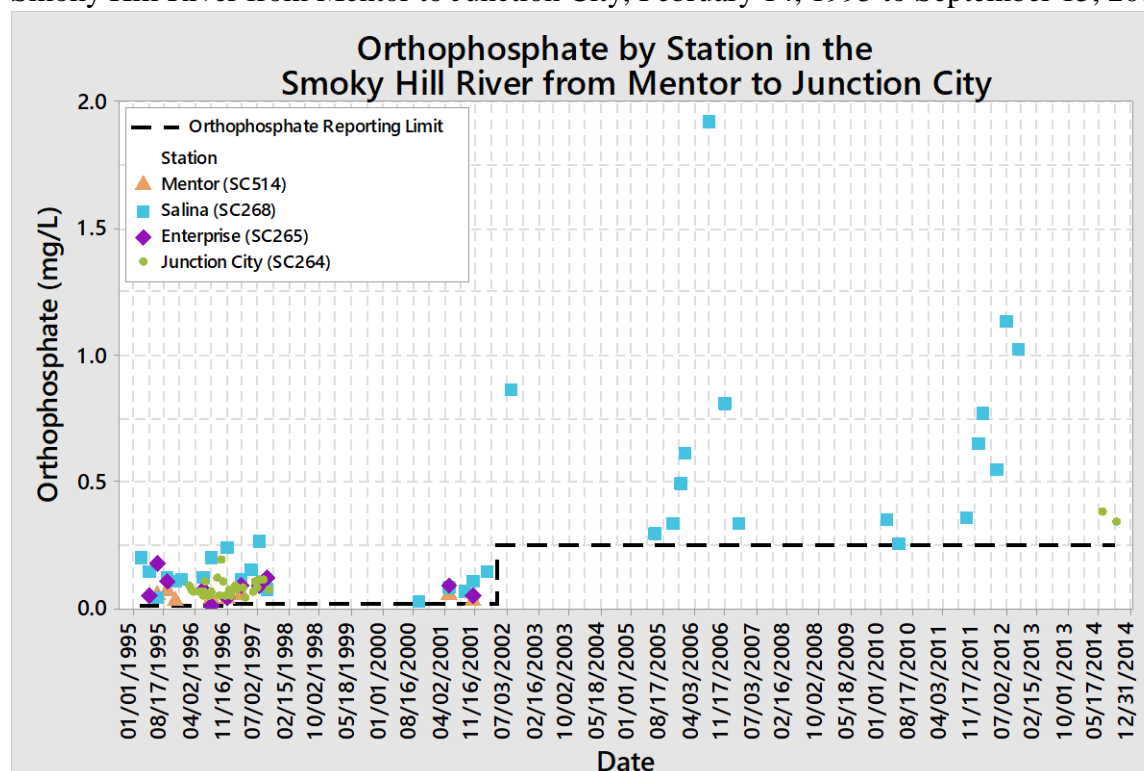
Table 7. Mean of detected orthophosphate (OP) samples, mean ratio of OP and total phosphorous (TP), sample number (N), and percentage of samples greater than the analytical reporting limit (> RL) separated by reporting limit increases in the Smoky Hill River from Mentor to Junction City, February 14, 1995 to September 15, 2014.

Station	Sample Information	Period of Record			
		1995-1996 (0.01 mg/L)	1997-Feb. 2002 (0.02 mg/L)	Mar. 2002-2014 (0.25 mg/L)	1995-2014
Mentor (SC514)	Mean (mg/L)	0.038	0.040	—	0.039
	Mean Ratio OP:TP	0.334	0.216	—	0.290
	N	5	3	—	8
	Sample Percent > RL	45%	18%	0%	10%
Salina (SC268)	Mean (mg/L)	0.141	0.110	0.670	0.382
	Mean Ratio OP:TP	0.508	0.342	0.708	0.558
	N	9	9	16	34
	Sample Percent > RL	82%	53%	29%	41%
Enterprise (SC265)	Mean (mg/L)	0.073	0.088	—	0.080
	Mean Ratio OP:TP	0.168	0.183	—	0.174
	N	6	5	—	11
	Sample Percent > RL	46%	29%	0%	13%
Junction City (SC264)	Mean (mg/L)	0.076	0.081	0.360	0.098
	Mean Ratio OP:TP	0.260	0.217	0.698	0.275
	N	17	10	2	29
	Sample Percent > RL	68%	53%	11%	46%

Definition: — no data

There are few instances of OP detection and no instances of OP concentrations exceeding 0.1 mg/L near Mentor (SC514; **Figure 29**). Additionally, this station has had no OP detections since reporting levels were increased to 0.25 mg/L in 2002. Near Salina (SC268), OP is detected throughout the period of record, with OP concentrations consistently exceeding 0.25 mg/L after 2002. Salina (SC268) also has the highest OP concentration of all the stations, reaching 1.92 mg/L in 2006. Similar to Mentor (SC514), there are few instances of OP detection and few instances of OP concentrations exceeding 0.1 mg/L at Enterprise (SC265); additionally, this station has had no OP detections since reporting levels were increased to 0.25 mg/L in 2002. There have been few recent detections of OP at Junction City (SC264), which is partially due to this station's rotational sampling status; however, while instances of detection have declined, OP detections in 2014 indicate that OP concentrations can be elevated at this station, with a mean of approximately 0.360 mg/L since 2002. Increased incidences of OP detection and elevated OP concentrations near Salina (SC268) and at Junction City (SC264) are likely indicative of point source influences due to the contribution of municipal effluent at these stations.

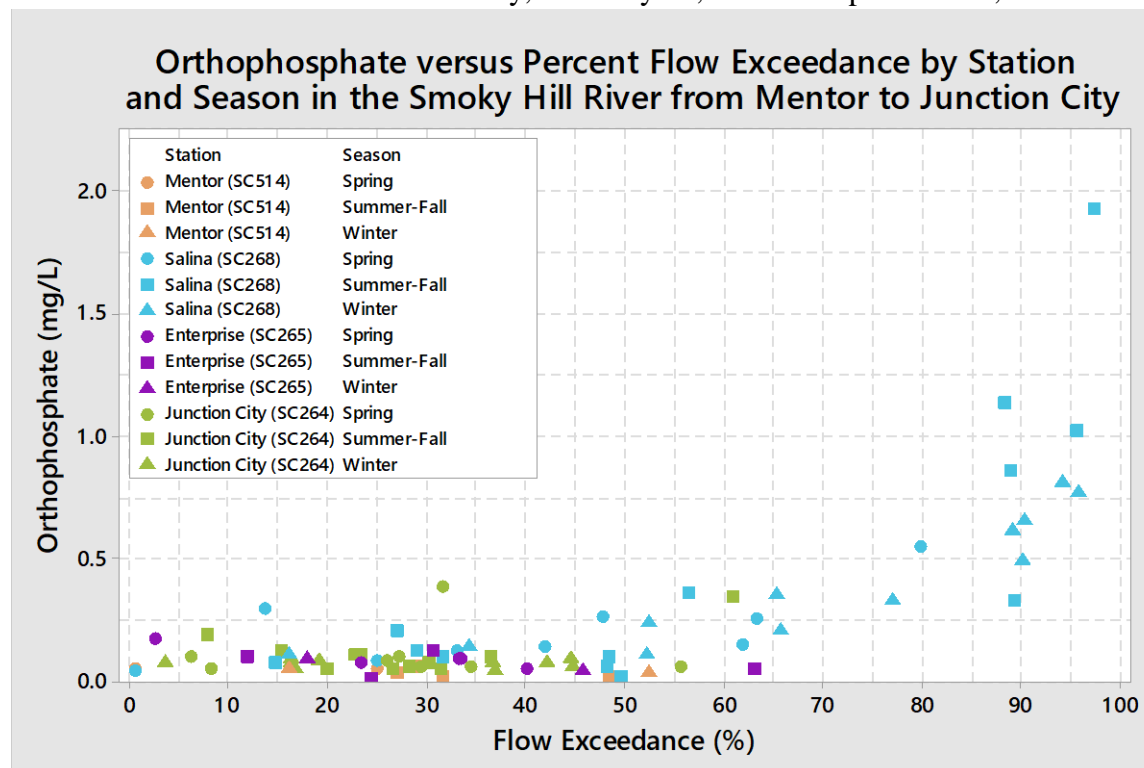
Figure 29. Orthophosphate samples measuring greater than the reporting limit by station in the Smoky Hill River from Mentor to Junction City, February 14, 1995 to September 15, 2014.



Further indication of point source influence is evident during various flow conditions and seasons (**Figure 30**). Higher OP concentrations are primarily detected during low flow conditions during summer-fall and winter. All OP concentrations detected under these conditions were from Salina (SC268). While there are no low flow samples for Junction City (SC264), OP concentrations at Junction City (SC264) within the 50 to 75% flow exceedance range also display an increase in OP concentration. During high flow conditions, OP

concentrations generally remain below 0.25 mg/L. High OP concentrations during low flow conditions and low OP concentrations during high flow conditions, as observed in the Smoky Hill River from Mentor to Junction City, are indicative of point sources entering the river, likely from municipal WWTPs.

Figure 30. Orthophosphate versus percent flow exceedance by station and season in the Smoky Hill River from Mentor to Junction City, February 14, 1995 to September 15, 2014.



Total Suspended Solids

Phosphorus has a high affinity for fixation in soils, where it is adsorbed from soil solution. Erosion of phosphorus-laden soil particles is a common means for phosphorus to enter streams, where it is then desorbed. This natural propensity for adsorption and desorption to soil particles creates a positively correlated relationship between TP and TSS that is evident at all stations in the Smoky Hill River, except for Salina (SC268; **Figures 31-34**). Mentor (SC514), Enterprise (SC265), and Junction City (SC264) all display a strong correlation between TP and TSS, with R^2 values greater than 0.80. Only Salina (SC268) displays a poor correlation, with an R^2 value of 0.09.

Figure 31. Total phosphorus versus total suspended solids and total phosphorus versus total suspended solids by percent flow exceedance near Mentor (SC514) in the Smoky Hill River.

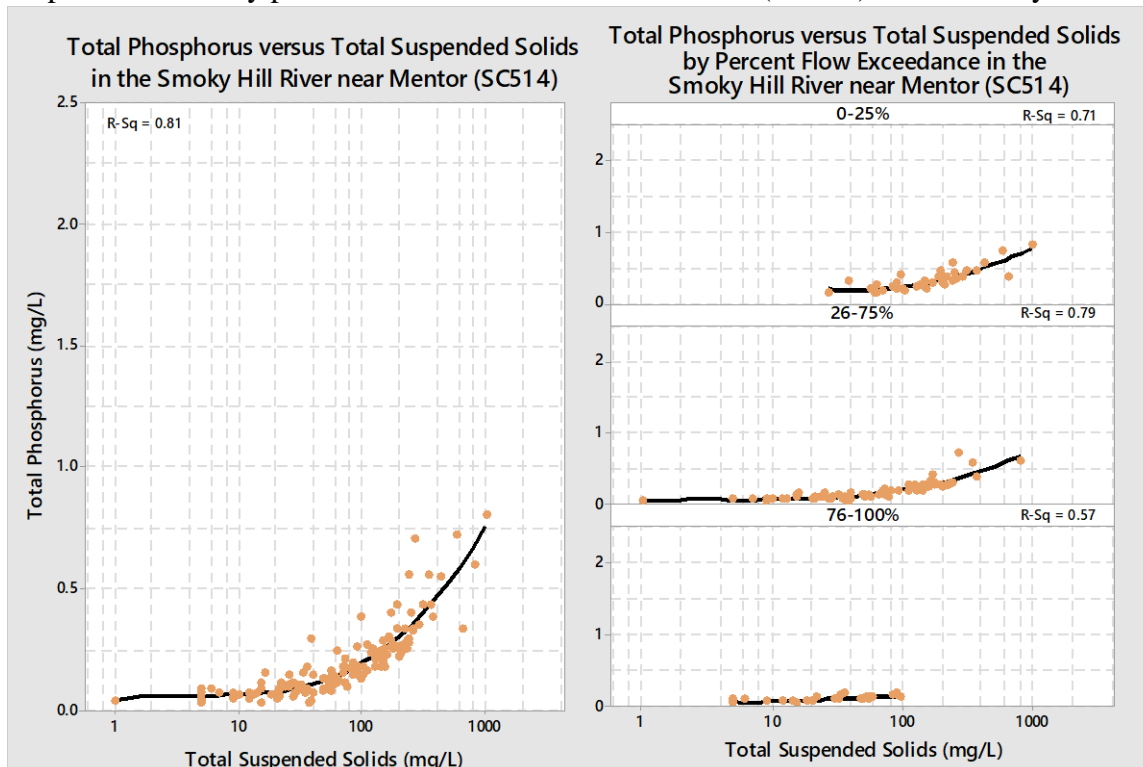


Figure 32. Total phosphorus versus total suspended solids and total phosphorus versus total suspended solids by percent flow exceedance near Salina (SC268) in the Smoky Hill River.

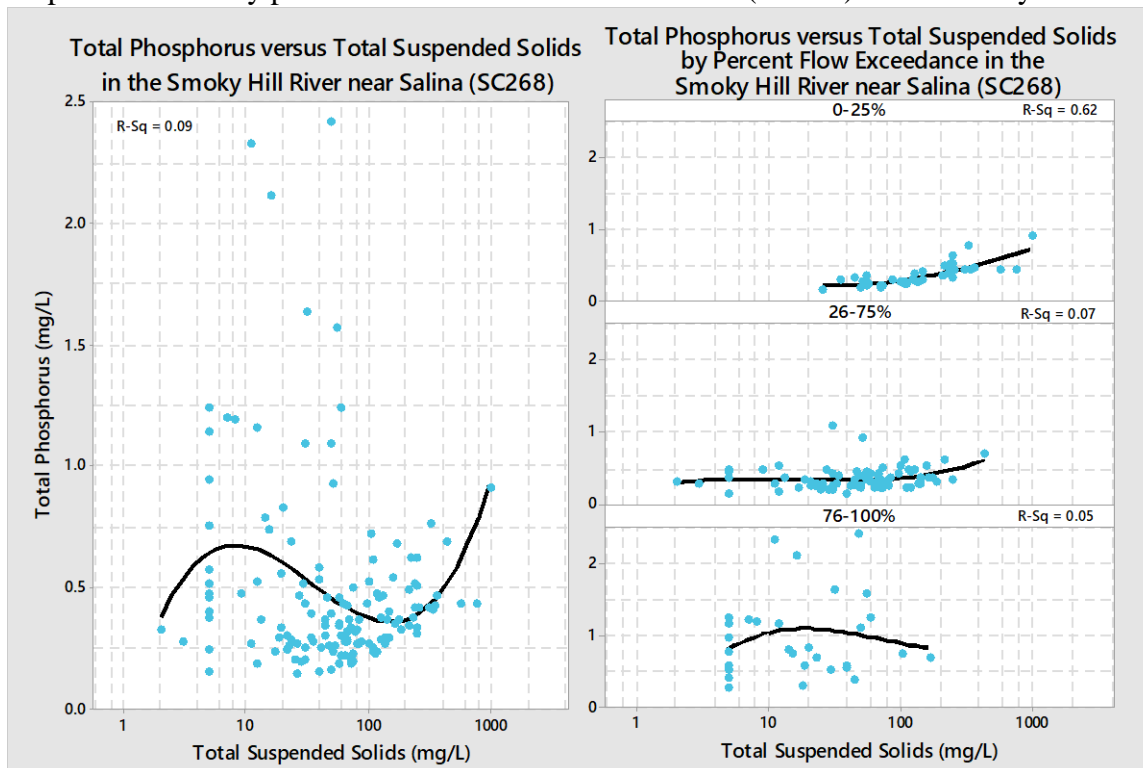


Figure 33. Total phosphorus versus total suspended solids and total phosphorus versus total suspended solids by percent flow exceedance at Enterprise (SC265) in the Smoky Hill River.

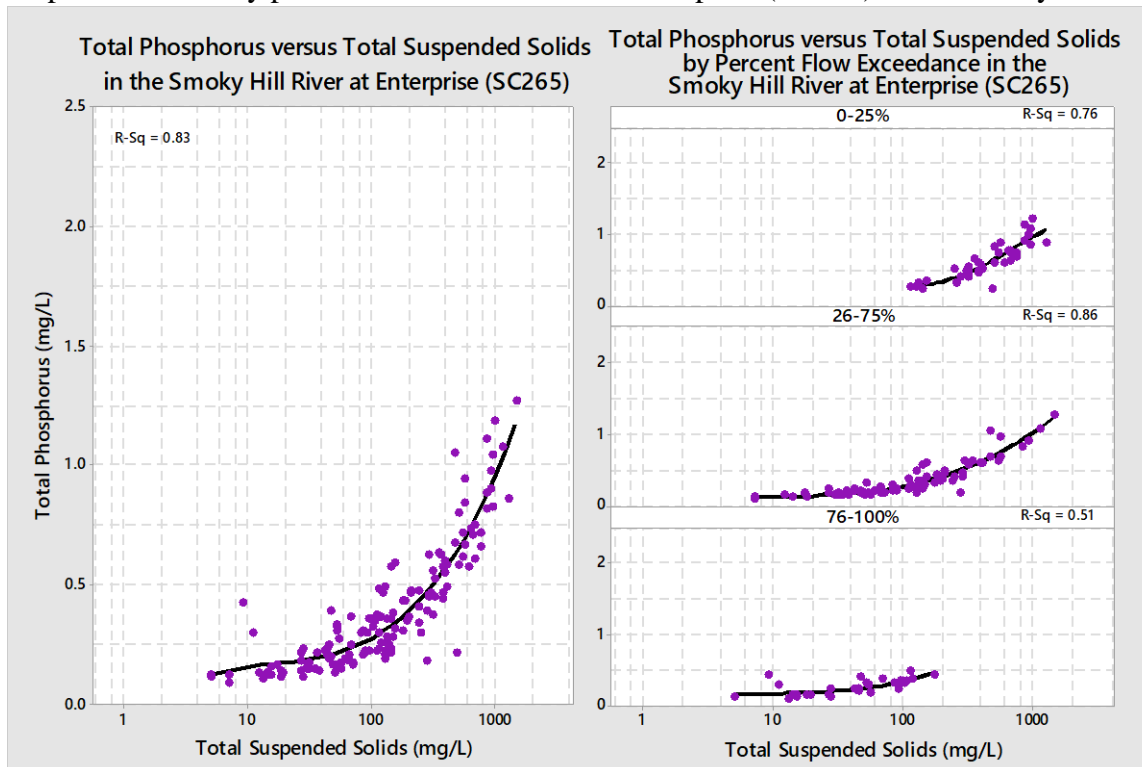
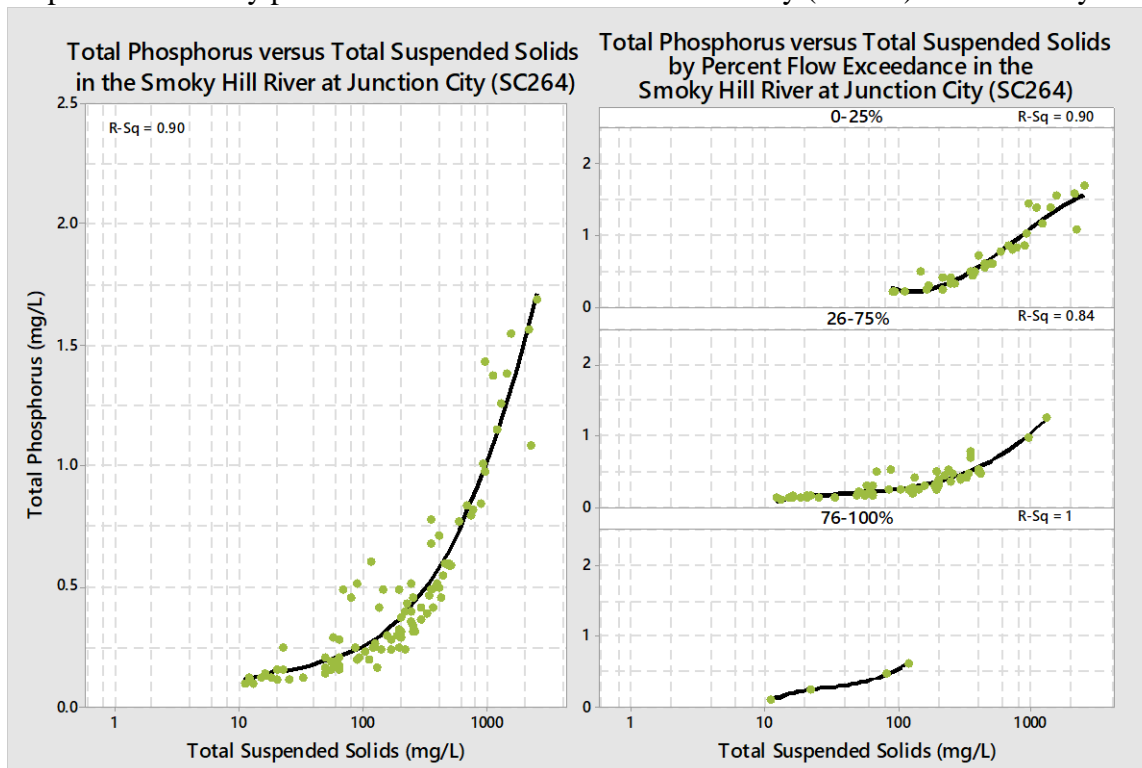


Figure 34. Total phosphorus versus total suspended solids and total phosphorus versus total suspended solids by percent flow exceedance at Junction City (SC264) in the Smoky Hill River.



Additionally, the relationship between TP and TSS is especially well-defined during high flow conditions for all four stations; however, Salina (SC268) has the weakest correlation. Stations with strong TP and TSS correlations during high flows are generally influenced by nonpoint and runoff sources of TP. During normal flow conditions, a strong correlation is maintained at Mentor (SC514), Enterprise (SC265), and Junction City (SC264). Salina (SC268), however, loses all correlation at normal and low flows. The correlation during low flows remains significant but becomes weaker for Mentor (SC514) and Enterprise (SC265). Low flow conditions have a perfect correlation at Junction City (SC264), though interpretation is limited at this station due to the small number of low flow samples. Stations with a weak relationship between TP and TSS during low flows, such as Salina (SC268), are generally influenced by municipal point source effluent, which increases TP concentrations irrespective of TSS concentrations due to elevated TP concentrations in the discharge.

Total Phosphorus and Biological Indicators

The narrative criteria of the Kansas Surface Water Quality Standards are based on conditions of the prevailing biological community. Excessive primary productivity may be indicated by extreme shifts in dissolved oxygen (DO), dissolved oxygen saturation (DO saturation), and pH as the chemical reactions of photosynthesis and respiration alter the ambient levels of oxygen and acid-base balance of the stream. These shifts, in turn, can result in undesirable regime shifts in the algal biomass and biological community within the stream.

Dissolved Oxygen

At all sites in the Smoky Hill River, dissolved oxygen and temperature are inversely related (**Figures 35-38**). This corresponds to seasonal changes in DO and temperature, where low mean DO concentrations occur in spring and summer-fall when temperatures are highest, and high mean DO concentrations occur in winter when temperatures are lowest (**Table 8**). This relationship is expected because oxygen becomes less soluble in water as temperatures increase. Additionally, DO exhibits a diel trend due to daily fluctuations in photosynthetic activity. The presented data captures this daily variability based upon whether a sample was collected in the morning (7:15 am to 12:00 pm) or afternoon (12:03 to 19:27 pm; **Table 9**); morning samples tend to have lower DO concentrations and afternoon samples tend to have higher DO concentrations. The exception to this trend is Junction City, which has two samples collected in the afternoon, both of which have lower DO concentrations than the majority of samples collected in the morning. All stations within the watershed have a DO excursion below the water quality criterion of 5 mg/L, except for Junction City (SC264): Mentor (SC514) has an excursion of 4.5 mg/L in May 1998; Salina (SC268) has excursions of 4.5 and 3.7 mg/L in May 1992 and September 2000, respectively; and Enterprise (SC265) has excursions of 4.8 and 4.6 mg/L in July 2006 and June 2011, respectively.

Figure 35. Dissolved oxygen and the relationship between dissolved oxygen and temperature near Mentor (SC514) in the Smoky Hill River.

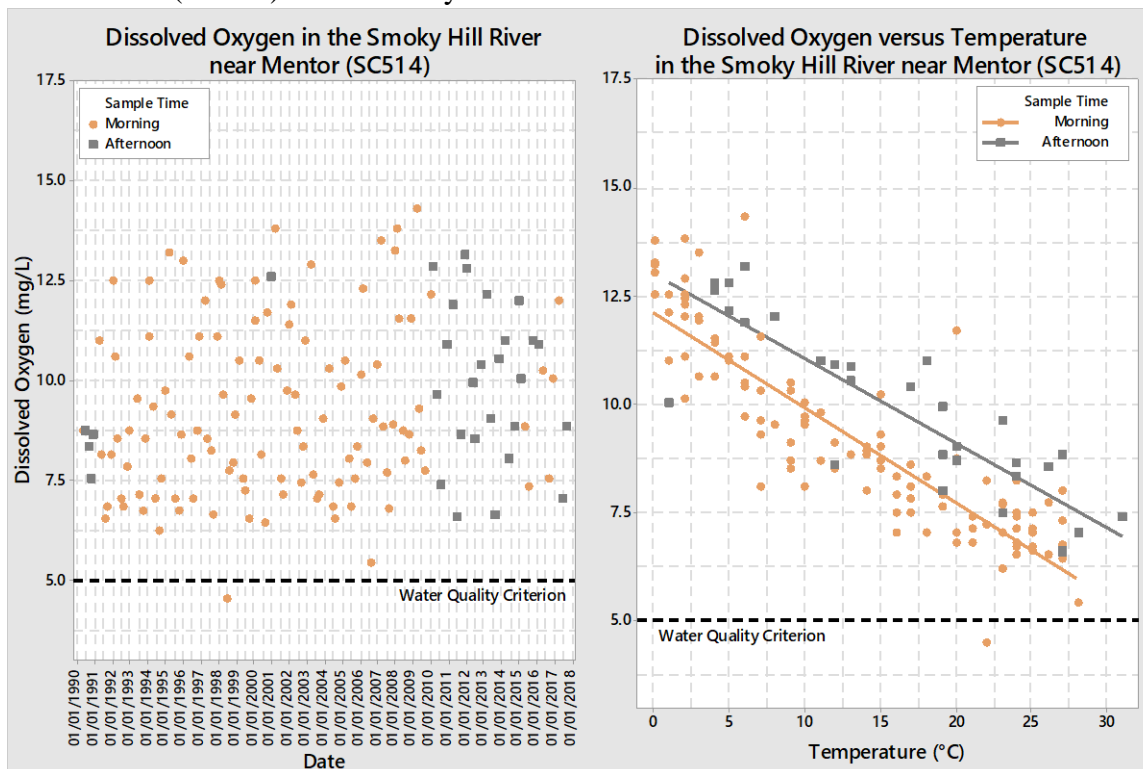


Figure 36. Dissolved oxygen and the relationship between dissolved oxygen and temperature near Salina (SC268) in the Smoky Hill River.

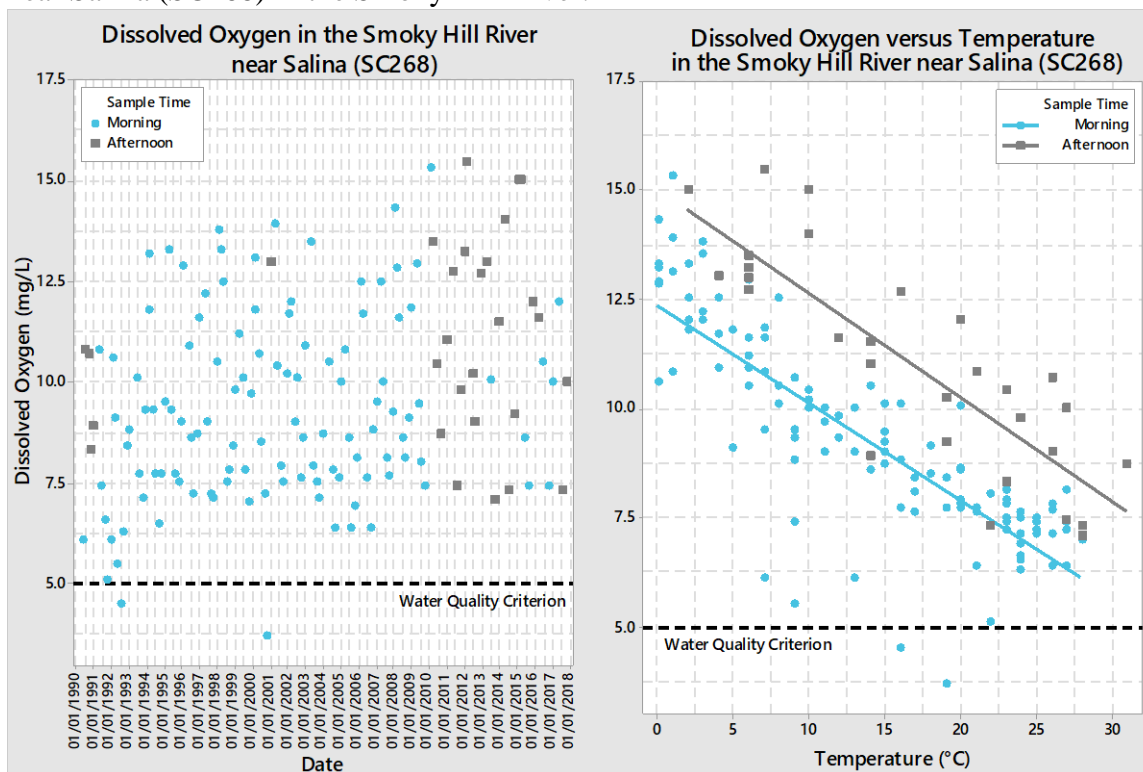


Figure 37. Dissolved oxygen and the relationship between dissolved oxygen and temperature at Enterprise (SC265) in the Smoky Hill River.

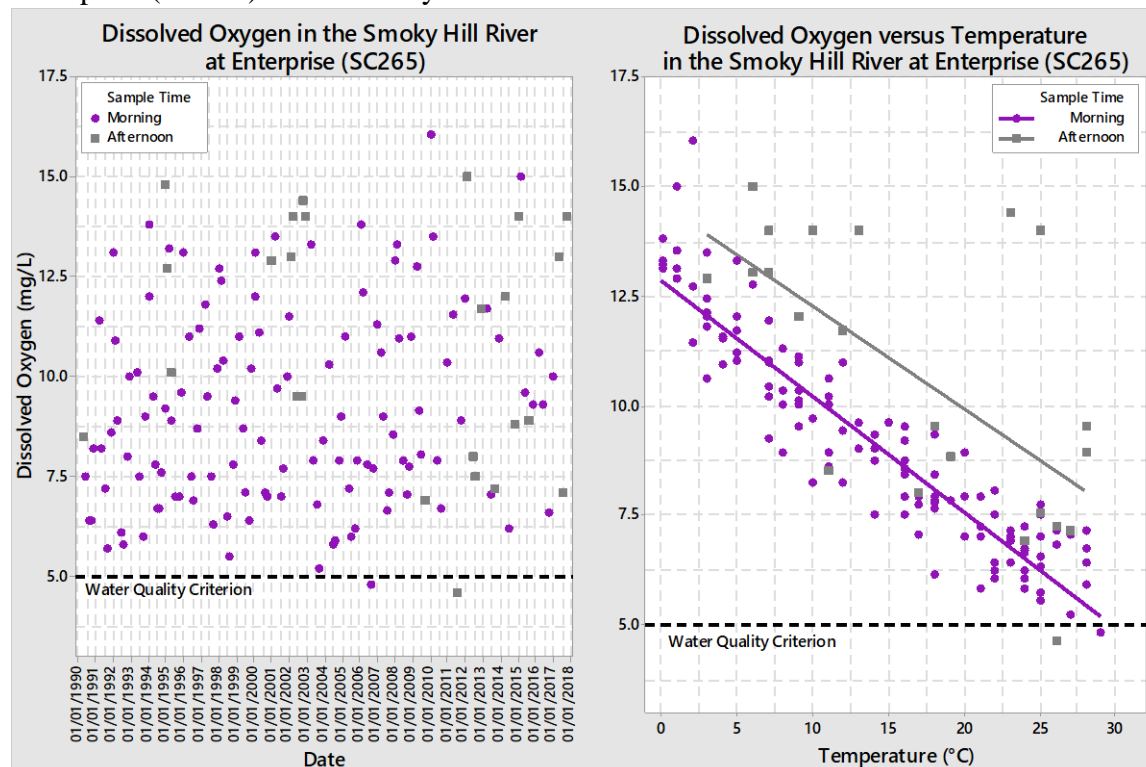


Figure 38. Dissolved oxygen and the relationship between dissolved oxygen and temperature at Junction City (SC264) in the Smoky Hill River.

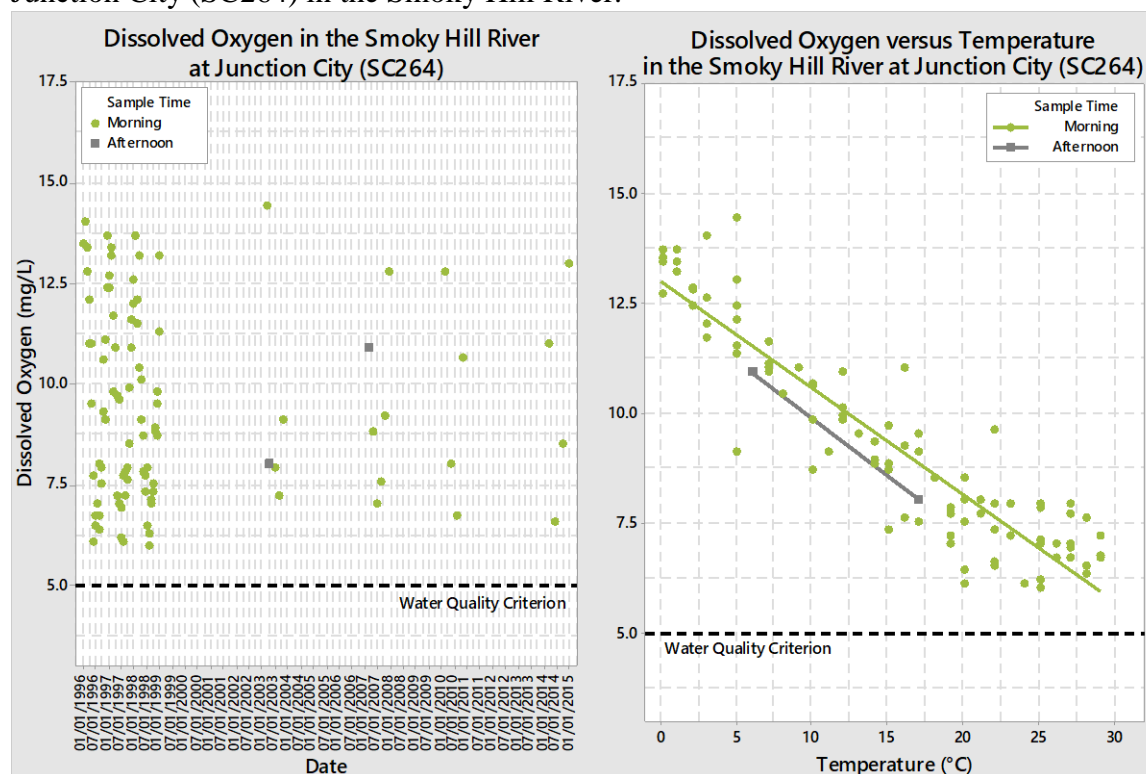


Table 8. Mean temperature, dissolved oxygen, and dissolved oxygen saturation, as well as median pH, by season in the Smoky Hill River from Mentor to Junction City.

Station	Spring	Summer-Fall	Winter	All Seasons
<i>Temperature (°C)</i>				
Mentor (SB514)	18.4	20.7	5.1	14.1
Salina (SB268)	18.7	21.0	5.7	14.4
Enterprise (SB265)	18.6	21.1	5.6	14.4
Junction City (SB264)	19.2	21.9	5.0	14.3
<i>Dissolved Oxygen (mg/L)</i>				
Mentor (SB514)	8.0	8.0	11.4	9.3
Salina (SB268)	8.4	8.1	11.8	9.6
Enterprise (SB265)	7.7	7.9	11.9	9.4
Junction City (SB264)	8.0	7.7	11.9	9.5
<i>Dissolved Oxygen Saturation (%)</i>				
Mentor (SB514)	85	88	89	88
Salina (SB268)	90	91	93	91
Enterprise (SB265)	81	87	94	88
Junction City (SB264)	86	87	92	89
<i>pH</i>				
Mentor (SB514)	7.9	7.9	7.9	7.9
Salina (SB268)	8.0	8.0	7.9	8.0
Enterprise (SB265)	7.9	8.0	8.0	8.0
Junction City (SB264)	8.0	8.0	7.9	8.0

Table 9. Mean dissolved oxygen and dissolved oxygen saturation by diel variability in the Smoky Hill River from Mentor to Junction City.

Station	Dissolved Oxygen (mg/L) – Morning	Dissolved Oxygen (mg/L) – Afternoon	Dissolved Oxygen Saturation (%) – Morning	Dissolved Oxygen Saturation (%) – Afternoon
Mentor (SB514)	9.2	9.8	85	97
Salina (SB268)	9.3	11.0	87	110
Enterprise (SB265)	9.2	10.9	85	104
Junction City (SB264)	9.5	9.5	89	85

Dissolved Oxygen Saturation

Primary productivity increases in the spring and summer-fall, when temperatures are higher and DO concentrations are lower. When primary productivity is excessive, oxygen from aquatic photosynthesis can create DO concentrations that exceed the natural oxygen equilibrium of the stream at a given temperature. The stream is considered supersaturated with oxygen when the expected oxygen capacity of the stream at a given temperature exceeds a DO saturation of 110%. Because of the system's diel characteristics, supersaturated conditions are more likely to be detected in the afternoon when photosynthesis and temperatures are at their peak.

All stations along the Smoky Hill River display supersaturated conditions exceeding 110% DO saturation throughout the period of record (**Figures 39-42**). The stations with the most frequent excursions greater than 110% DO saturation are Salina (SC268) and Enterprise (SC265), with excursions occurring throughout all temperature ranges (**Figures 40-41**). Notably, these excursions are dominated by samples collected in the afternoon. The stations with the fewest excursions above 110% are Mentor (SC514) and Junction City (SC264; **Figures 39** and **42**). Overall, mean DO saturation samples at all stations do not exceed 110% and are within the range of 81 to 94% throughout all seasons. The station with the most frequent high DO saturation is Salina (SC268), which has the highest overall mean DO saturation of 91%.

pH

Another water quality indicator of primary productivity is pH, as photosynthesis can increase pH by removing carbon dioxide from the water. The numeric water quality criteria for pH is a range from 6.5 to 8.5. None of the stations in the Smoky Hill River from Mentor to Junction City have pH values less than 6.5 (**Figures 43-46**), and Mentor (SC514) and Salina (SC268) have never had excursions greater than 8.5 (**Figures 43-44**). The only stations with pH values greater than 8.5 are Enterprise (SC265) and Junction City (SC264), with both stations having an excursion of 8.6 in October 2003 (**Figures 45-46**). Median pH remains relatively consistent among all stations and throughout all seasons, ranging from 7.9 to 8.0.

Figure 39. Dissolved oxygen saturation and the relationship between dissolved oxygen saturation and temperature near Mentor (SC514) in the Smoky Hill River.

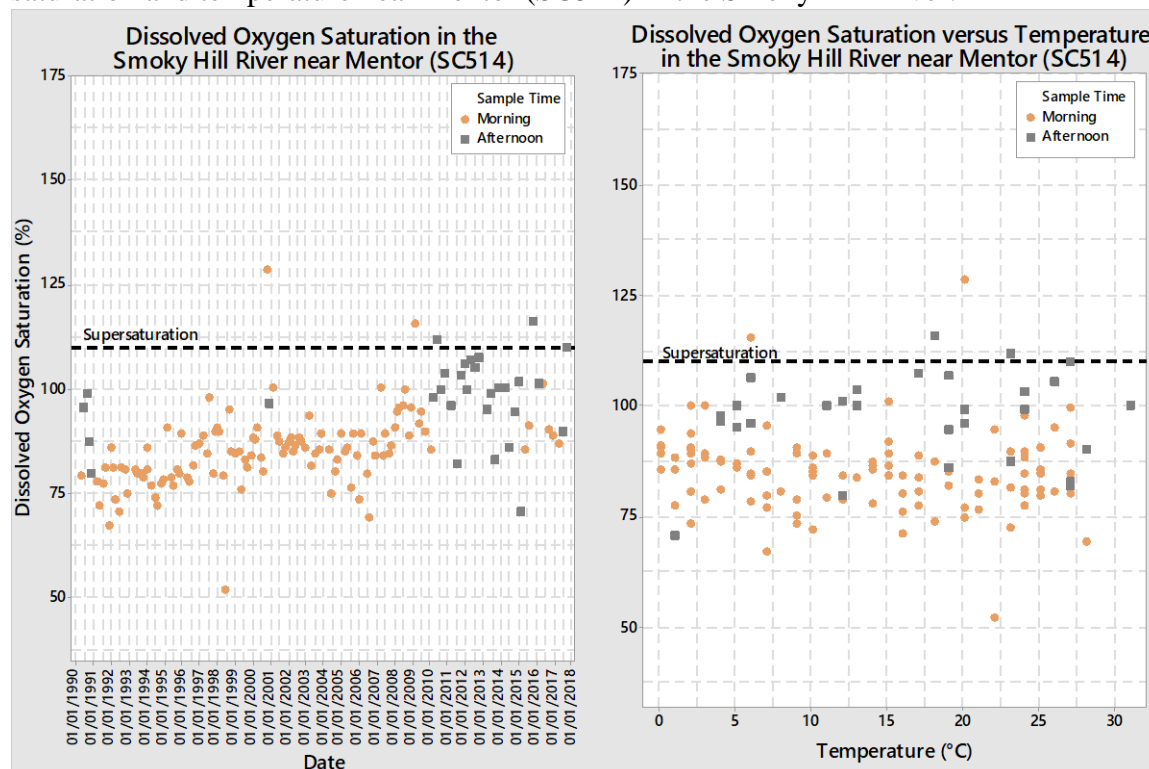


Figure 40. Dissolved oxygen saturation and the relationship between dissolved oxygen saturation and temperature near Salina (SC268) in the Smoky Hill River.

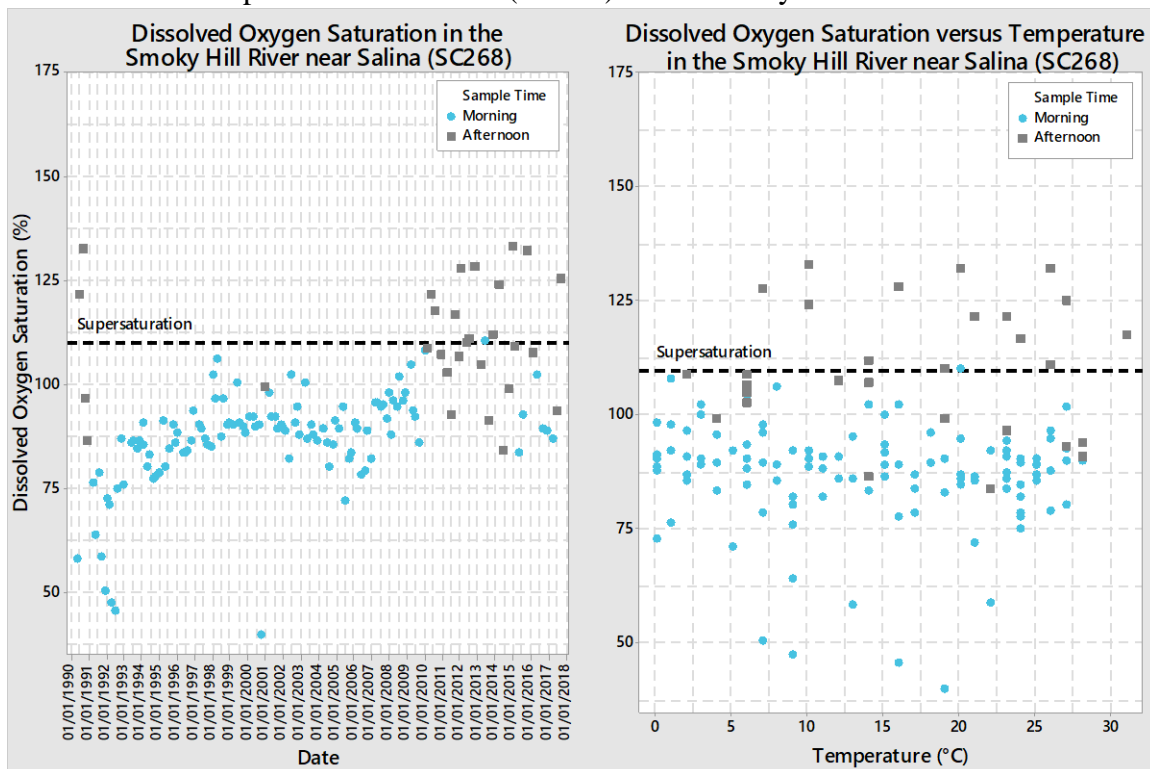


Figure 41. Dissolved oxygen saturation and the relationship between dissolved oxygen saturation and temperature at Enterprise (SC265) in the Smoky Hill River.

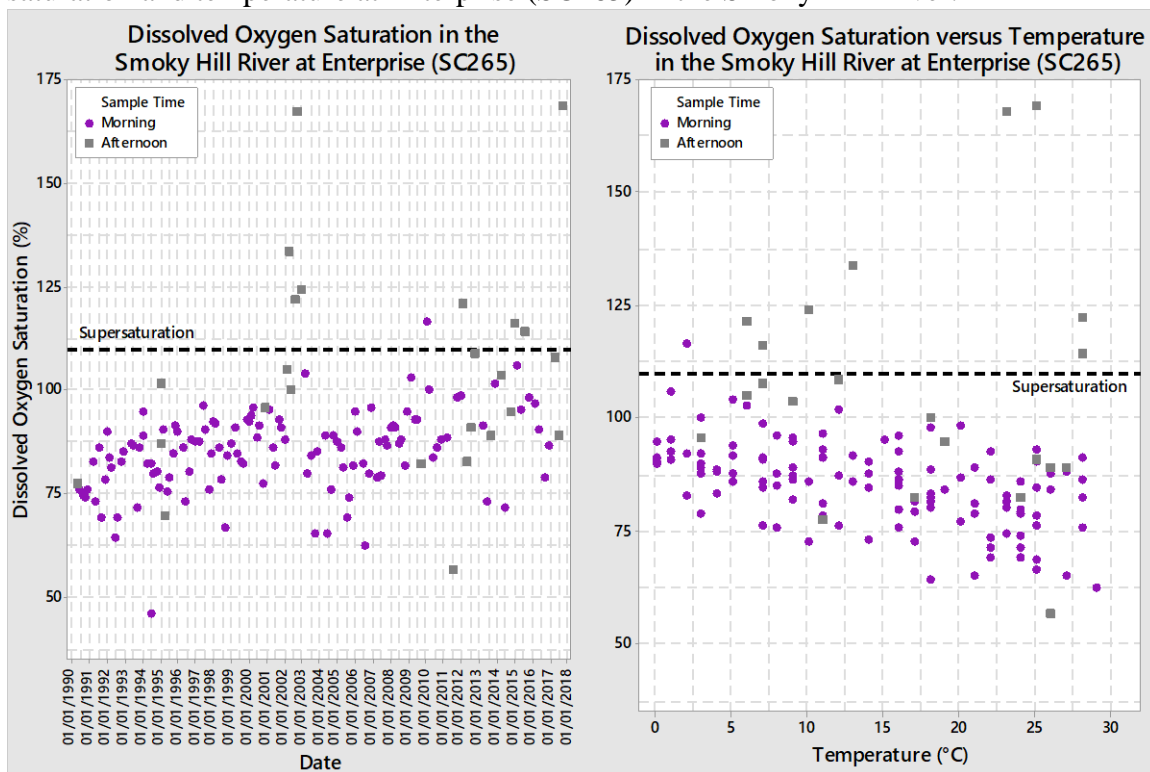


Figure 42. Dissolved oxygen saturation and the relationship between dissolved oxygen saturation and temperature at Junction City (SC264) in the Smoky Hill River.

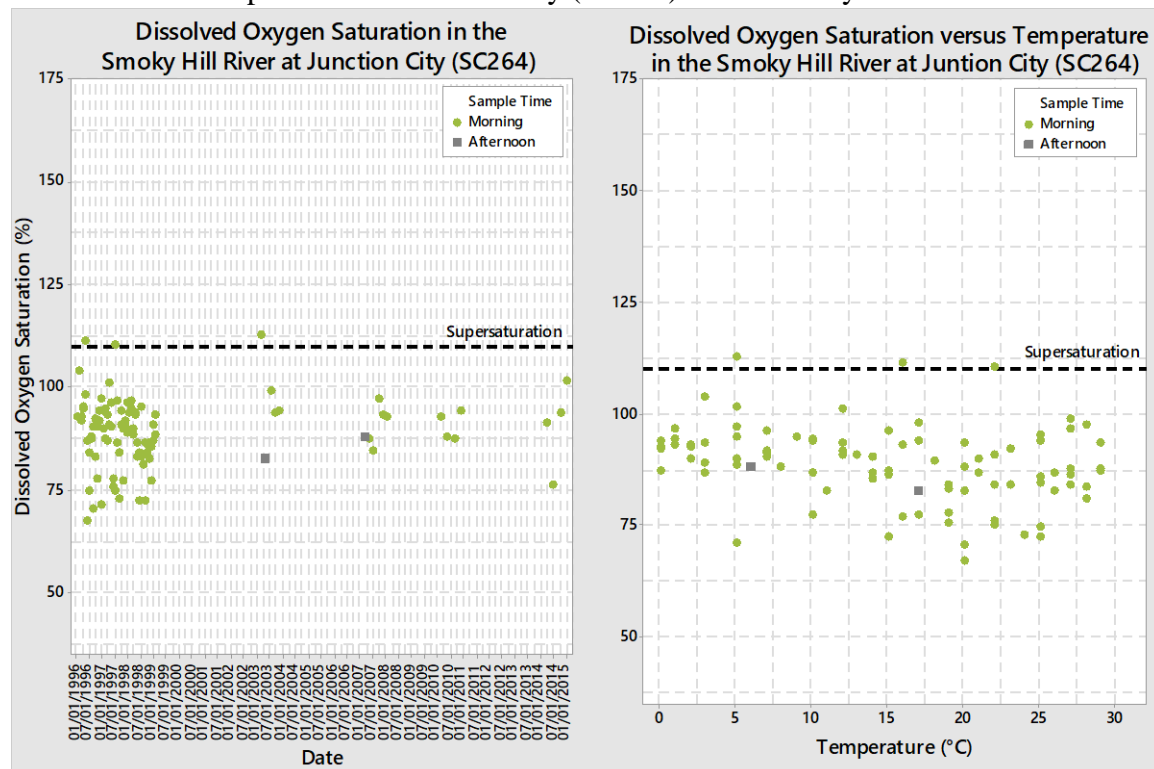


Figure 43. The pH and the relationship between pH and temperature near Mentor (SC514) in the Smoky Hill River.

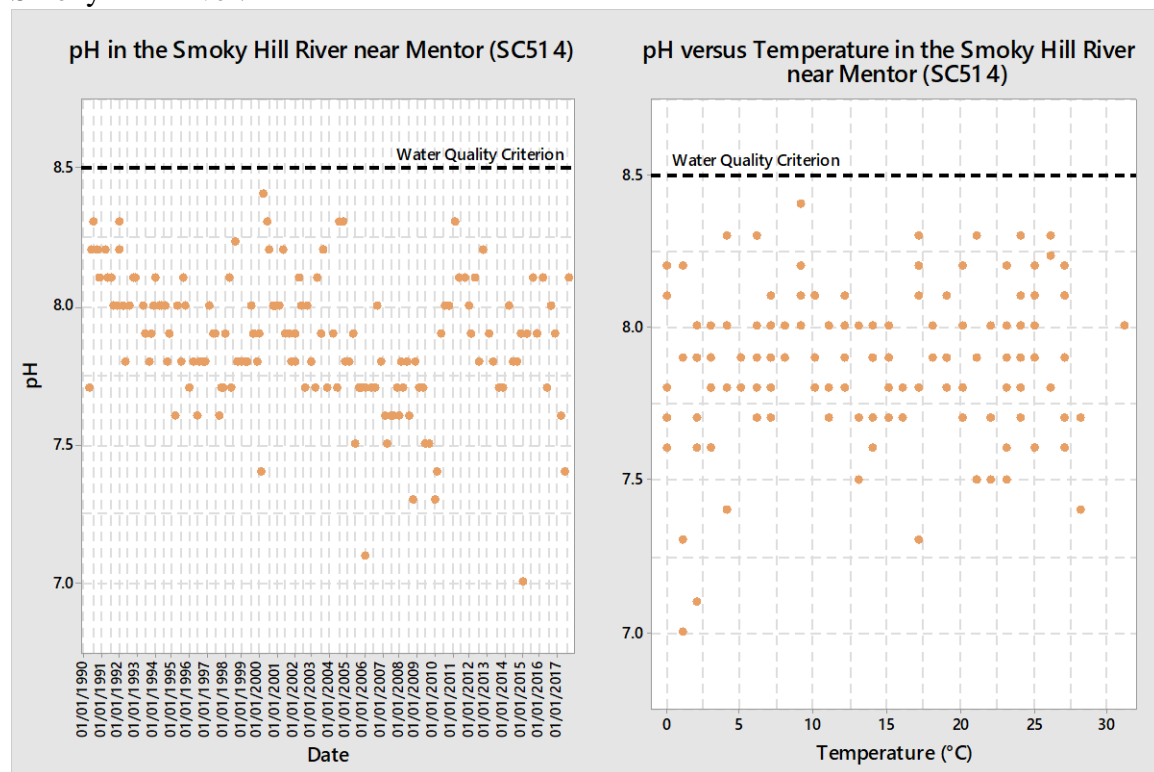


Figure 44. The pH and the relationship between pH and temperature near Salina (SC268) in the Smoky Hill River.

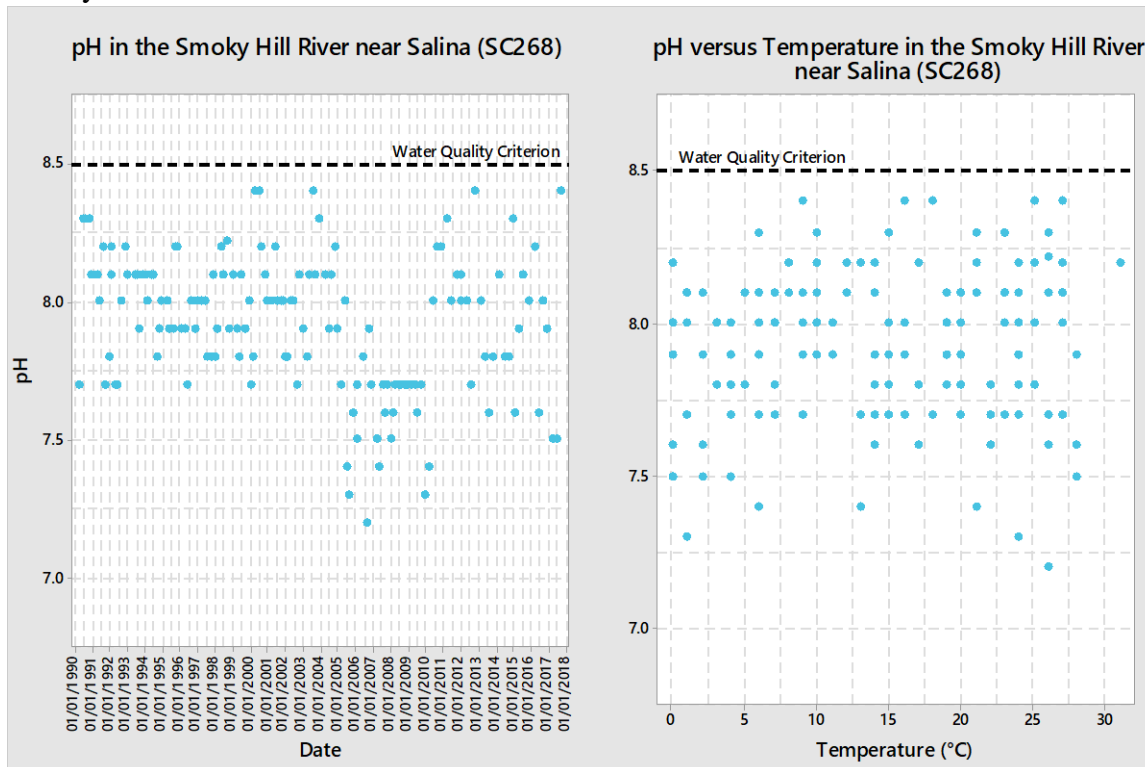


Figure 45. The pH and the relationship between pH and temperature at Enterprise (SC265) in the Smoky Hill River.

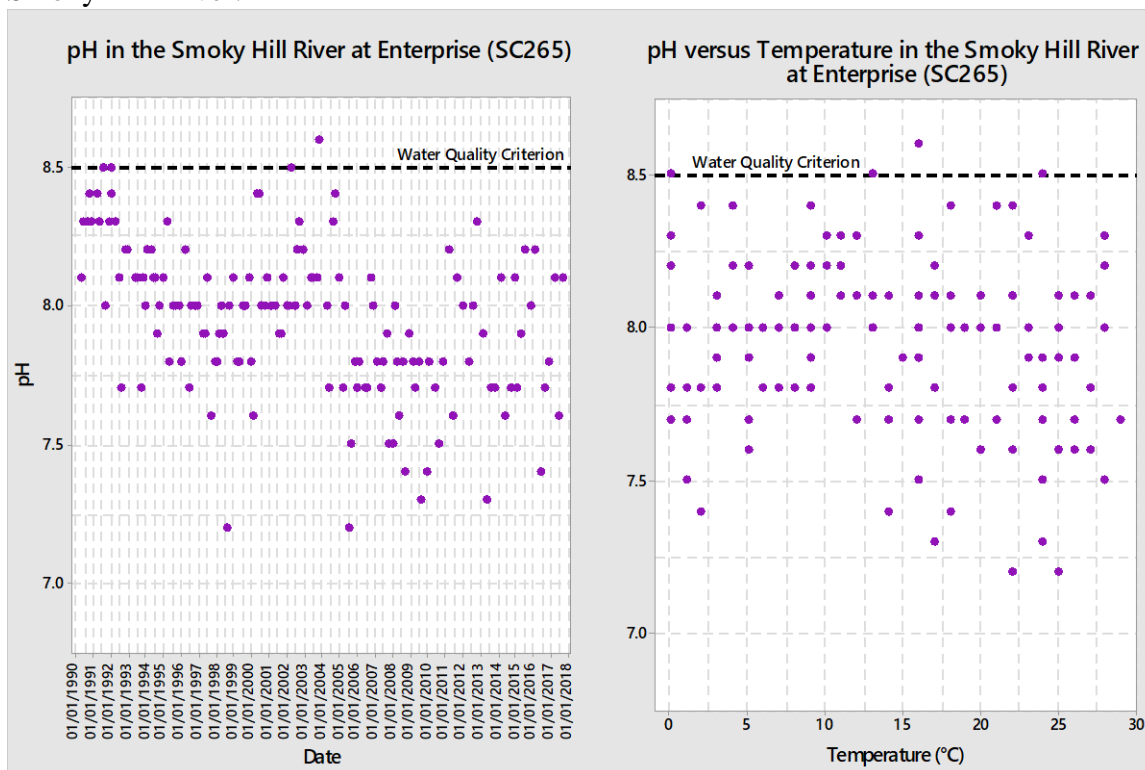
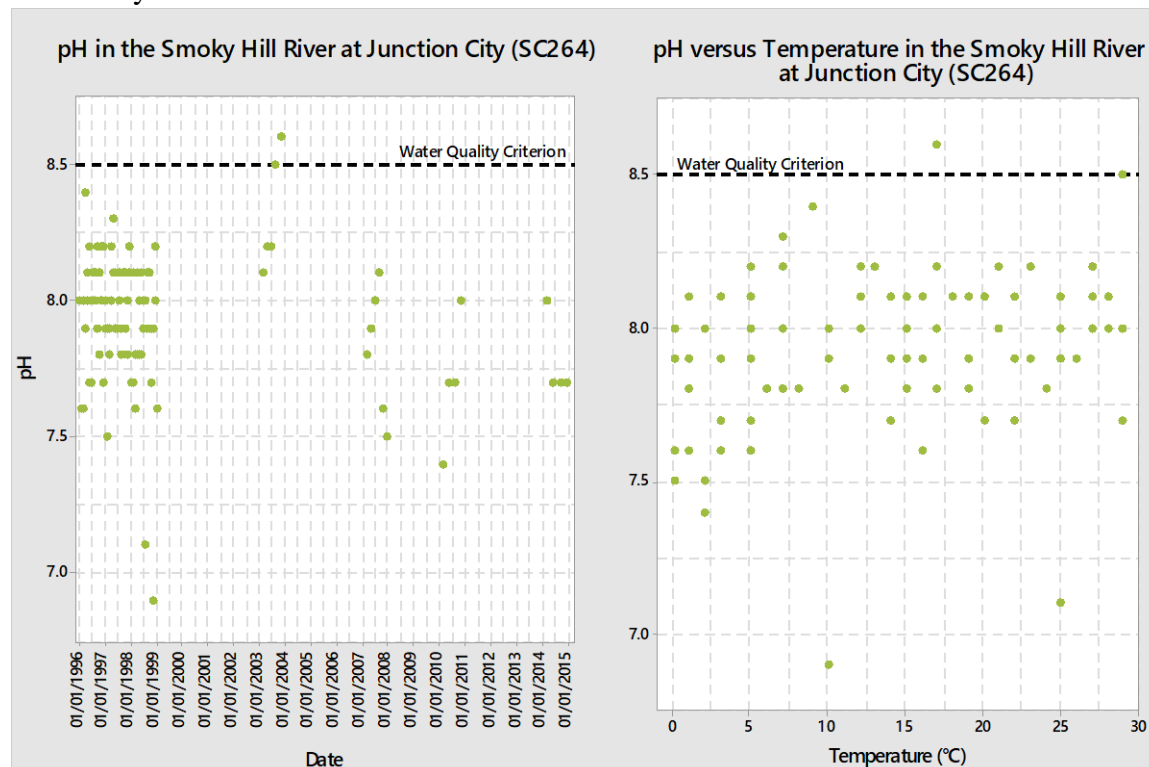


Figure 46. The pH and the relationship between pH and temperature at Junction City (SC264) in the Smoky Hill River.



Algal Biomass

Chlorophyll-*a* is a photosynthetic pigment found in algae, and its concentration is commonly used as a measure of the algal biomass present in streams. Because nutrients directly influence primary production, the U.S. Environmental Protection Agency (USEPA) guidance on nutrient criteria for streams establishes a chlorophyll-*a* concentration range of 8 to 15 micrograms per liter ($\mu\text{g/L}$) before overall biology can become adversely impacted (U.S. Environmental Protection Agency, 2000).

There are a limited number of chlorophyll-*a* samples collected in the Smoky Hill River from Mentor to Junction City. Two chlorophyll-*a* samples have been collected by KDHE near Salina (SC268), one in January and one in April of 2015. The mean of these two samples is 10 $\mu\text{g/L}$. An additional six chlorophyll-*a* samples were collected by the USGS in Junction City (06879005) in September and October of 2011. The mean of these six samples is 67 $\mu\text{g/L}$. Available chlorophyll-*a* data suggests that primary productivity may be adversely impacting biology in the Smoky Hill River.

Biological Community

Biological data regarding macroinvertebrate organisms and community are collected at KDHE stream biology (SB) stations. The sampled SB stations in the watershed for the Smoky Hill River are Mentor (SB514), Salina (SB268), Enterprise (SB265), and Junction City (SB264). The SB stations have been assessed using the Aquatic Life Use Support (ALUS) Index as described

in Kansas' 2018 303(d) Methodology. The ALUS Index score consists of five categorizations of biotic conditions:

1. Macroinvertebrate Biotic Index (MBI): A statistical measure that evaluates the effects of nutrients and oxygen demanding substances on aquatic and semi-aquatic macroinvertebrates based on the relative abundance of certain indicator taxa that is specific to the level of order and family.
2. Kansas Biotic Index for Nutrients (KBI-N): A statistical measure mathematically equivalent to the MBI that is restricted to aquatic insect macroinvertebrates and is species specific.
3. Ephemeroptera, Plecoptera, and Trichoptera (EPT): A measure of the richness of the intolerant aquatic EPT taxa within a macroinvertebrate sample used to evaluate the diversity within the sample.
4. EPT Percent of Count (EPT% CNT): The percentage of individuals belonging to the EPT orders in a sample of macroinvertebrates.
5. Shannon's Evenness (SHN EVN): A measure of diversity that describes how evenly distributed the numbers of individuals are among the taxa in a sample.

These metrics are used to establish a score (**Table 10**) which is then translated into an indication of the biotic condition and support category available for aquatic life in the stream (**Table 11**).

Table 10. Aquatic Life Use Support Index metrics with scoring ranges and standardized scores.

MBI	KBI-N	EPT	EPT% CNT	SHN EVN	Score
≤ 4.18	≤ 2.52	≥ 16	≥ 65	≥ 0.849	4
4.19-4.38	2.53-2.64	14-15	56-64	0.826-0.848	3
4.39-4.57	2.65-2.75	12-13	48-55	0.802-0.825	2
4.58-4.88	2.76-2.87	10-11	38-47	0.767-0.801	1
≥ 4.89	≥ 2.88	≤ 9	≤ 37	≤ 0.766	0

Table 11. Aquatic Life Use Support (ALUS) Index score range, interpretation of biotic condition, and aquatic life support category.

ALUS Index Score	Biotic Condition	Support Category
$> 16-20$	Very Good	Supporting
$> 13-16$	Good	
$> 7-13$	Fair	Partially Supporting
$> 4-6$	Poor	Non-supporting
0-3	Very Poor	

Biotic conditions were sampled annually near Mentor (SB514) from 1993 to 1996, near Salina (SB268) from 1990 to 2015 (except for 2008 and 2011), at Enterprise (SB265) in 2010, and at Junction City from 1990 to 2016 (except for 1993, 2008, 2010, and 2011; **Table 12**). The Mentor (SB514) station has a total of four samples with a mean ALUS Index score of 18, indicating biotic conditions are very good and supporting of aquatic life. The Salina (SB268) station has a total of 24 samples with a mean ALUS Index score of 11, indicating biotic conditions are fair and partially supporting of aquatic life. The Enterprise (SB265) station has one sample with an ALUS Index score of 16, indicating that biotic conditions are good and

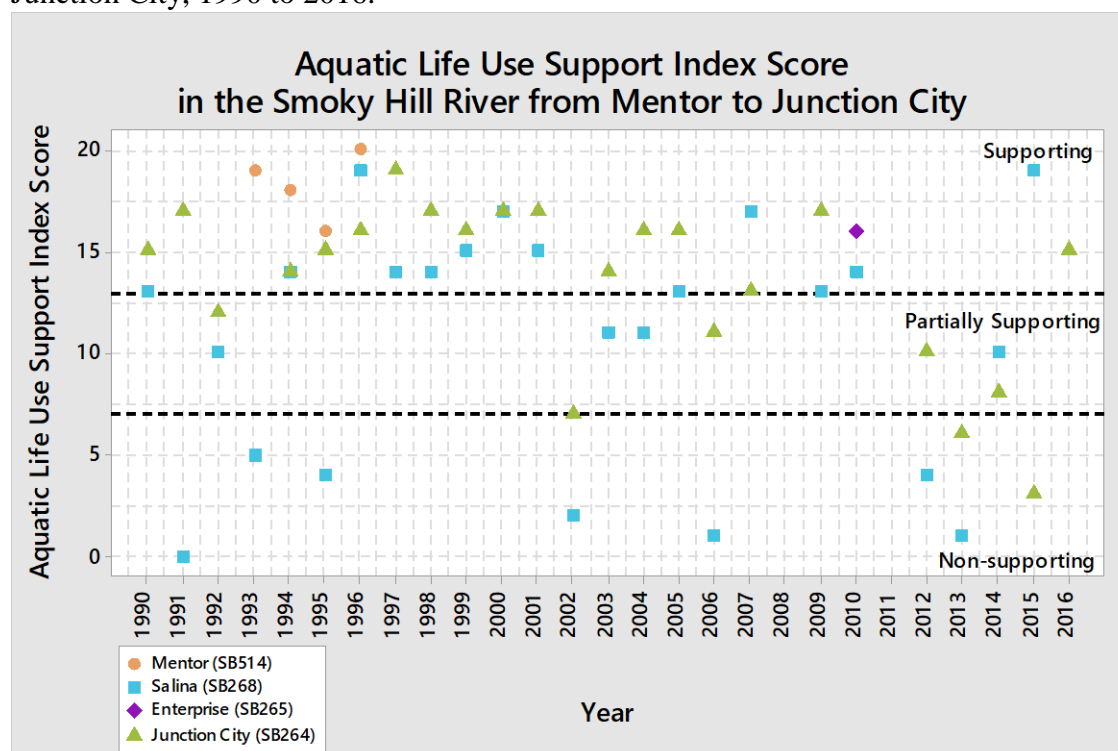
supporting of aquatic life. The Junction City (SB264) station has a total of 23 samples with a mean ALUS Index score of 14, indicating biotic conditions are good and supporting of aquatic life.

Table 12. Mean Aquatic Life Use Support (ALUS) Index scores in the Smoky Hill River from Mentor to Junction City.

Station	Period of Record	Number of Samples	Mean ALUS Index Score	Biotic Condition	ALUS Index Support Category
Mentor (SB514)	Oct. 20, 1993 to July 31, 1996	4	18	Very Good	Supporting
Salina (SB268)	Sep. 26, 1990 to July 8, 2015	24	11	Fair	Partially Supporting
Enterprise (SB265)	Aug. 9, 2010	1	16	Good	Supporting
Junction City (SB264)	July 19, 1990 to June 28, 2016	23	14	Good	Supporting

Although all four stations are either partially supporting or supporting of aquatic life, the stations near Salina (SB268) and at Junction City (SB264) sporadically have samples that are non-supporting of aquatic life (**Figure 47**). Notably, three of the non-supporting of aquatic life years near Salina (SB268) were 2002, 2006, and 2012; these years coincide with low flow conditions in the Smoky Hill River, creating conditions where point source effluent may become concentrated and have a greater impact on biota. Unlike 2002 and 2006, aquatic life struggled to re-establish itself after the period of low flow conditions in 2012.

Figure 47. Aquatic Life Use Support Index scores in the Smoky Hill River from Mentor to Junction City, 1990 to 2016.



Desired Endpoints for Water Quality (Implied Load Capacity) in the Smoky Hill River from Mentor to Junction City

The ultimate desired water quality (implied load capacity) endpoints of this TMDL for the Smoky Hill River from Mentor to the terminus of CUSEGA 102600081, below Junction City, will be to achieve the Kansas Water Quality Standards by eliminating the impacts to aquatic life, domestic water supply, and contact recreation associated with excessive phosphorus and objectionable flora as described in the narrative criteria pertaining to nutrients. There are currently no existing numeric phosphorus criteria in Kansas.

Current EPA nutrient philosophy is predicated upon 25th percentile stream TP concentrations within an ecoregion to indicate reference conditions. This generalization is not tied to specific biological conditions but represents water quality protection policy guiding EPA's administration of clean water programs. The U.S. EPA suggested TP reference benchmark for streams within the Level III Ecoregion Central Great Plains is a 25th percentile of 0.090 mg/L (U.S. Environmental Protection Agency, 2000). The Smoky Hill River TMDL Watershed primarily falls within the Level III Ecoregion Central Great Plains. Assessment of 129 KDHE SC stations within the Level III Ecoregion Central Great Plains with TP data from 2000 to 2017 indicates a 25th percentile of medians of 0.131 mg/L and a 50th percentile of medians of 0.210 mg/L (**Table 13**).

Table 13. Summary of Kansas Department of Health and Environment (KDHE) stream chemistry stations located in the Level III Ecoregion Central Great Plains from 2000 to 2017.

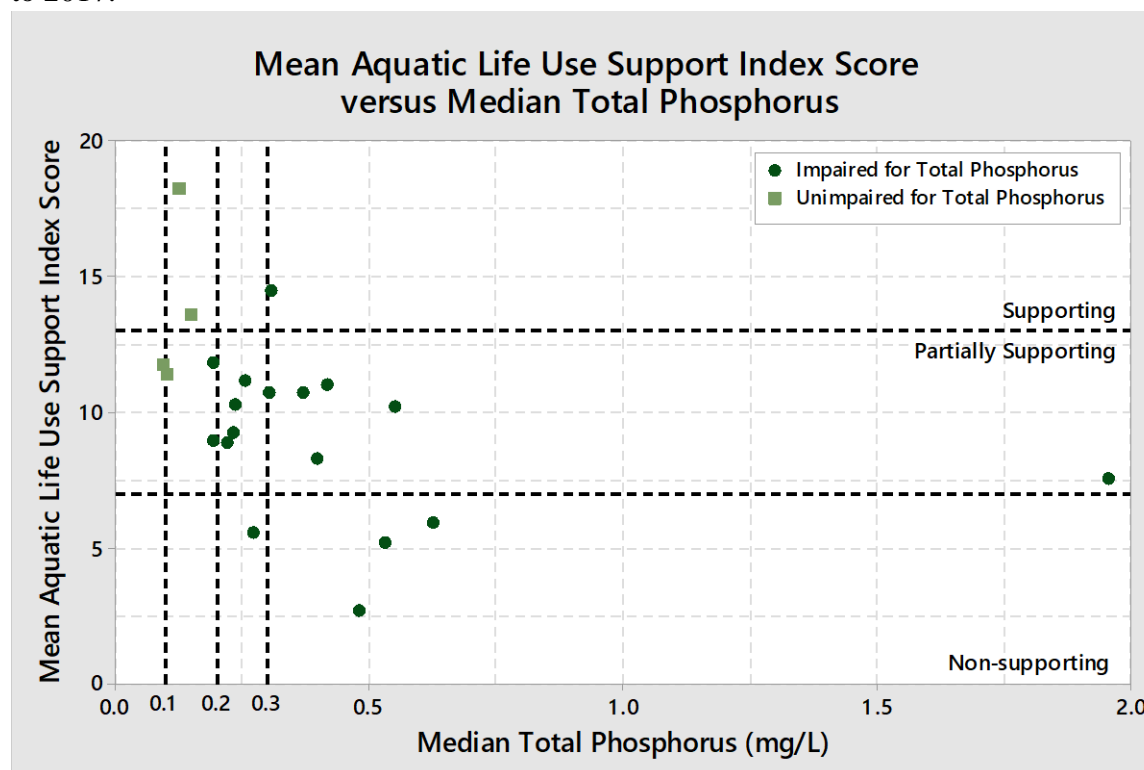
U.S. EPA Ecoregion	Number of KDHE Stations	Number of Samples	25 th Percentile of Medians (mg/L)	50 th Percentile of Medians (mg/L)	75 th Percentile of Medians (mg/L)
Central Great Plains	129	6,821	0.131	0.210	0.384

Of the 129 KDHE SC stations within the Level III Ecoregion Central Great Plains used for the TP milestone analysis, 21 have corresponding SB stations. An analysis of the mean ALUS Index versus the median TP concentration indicates that there are three SB stations supporting biology (**Figure 48**). Median TP concentrations for SB stations supporting biology range from 0.124 to 0.306 mg/L. The mean ALUS Index for stations supporting aquatic life is 15, while the mean ALUS Index for stations not supporting aquatic life is 9.

In general, the analysis of the mean ALUS Index versus the median TP concentration indicates that stations with greater TP concentrations are less supportive of biology. This relationship is variable, however. Such variability supports an adaptive management approach to reduce current TP concentrations and loads, rather than establishing a single, definitive threshold. Therefore, this TMDL seeks to establish an adaptive management approach in order to observe and respond to biological metrics to assess the impact of TP reductions. As such, the primary measure of phosphorus load reduction in the TMDL for impaired segments of the Smoky Hill River from Mentor to Junction City will be an improved ALUS Index. An ALUS Index score

greater than 13 at SB stations will serve to establish that the biological community reflects recovered or renewed diversity and minimal disruption by the impacts described in the narrative criteria for nutrients on aquatic life, recreation, and domestic water supply.

Figure 48. Aquatic Life Use Support (ALUS) Index versus median total phosphorus for stream biology and stream chemistry stations in the Level III Ecoregion Central Great Plains from 2000 to 2017.



Furthermore, secondary indicators of the health of the aquatic biological community will be assessed at SC stations. Dissolved oxygen concentrations will be monitored to ensure concentrations are greater than 5 mg/L. According to the Kansas Water Quality Standards, concentrations below this are low enough to put aquatic life under stress. Dissolved oxygen saturation will also be monitored for indication of overactive primary productivity, as indicated by supersaturated values greater than 110%. The pH will be monitored, as well, to ensure that overactive primary productivity is not altering stream chemistry; values should remain between 6.5 and 8.5 in order to protect aquatic life according to the Kansas Water Quality Standards. The chlorophyll-*a* concentration will serve as an additional biological measure of nutrient loading reduction in order to assess improvements in primary productivity and address its impacts as described in the narrative criteria for nutrients on aquatic life, recreation, and domestic water supply.

The numeric endpoints for stream segments in this TMDL, as measured in the Smoky Hill River at Salina (SC268), Enterprise (SC265), and Junction City (SC264), indicating attainment of water quality standards within the watershed are:

1. An ALUS Index score greater than 13 at SB stations.
2. Dissolved oxygen concentrations greater than 5.0 mg/L at SC stations.
3. Dissolved oxygen saturation less than 110% at SC stations.
4. Values within the range of 6.5 to 8.5 for pH at SC stations.
5. Median sestonic chlorophyll-*a* concentrations less than or equal to 10 µg/L at SC stations.

As there are currently no numeric phosphorus criteria in Kansas, the series of endpoints established by this TMDL will be the measure used to indicate full support of aquatic life, domestic water supply, and contact recreation in the Smoky Hill River. All five endpoints must initially be maintained over three consecutive years to constitute full support of the designated uses of the impaired stream segments in this TMDL, as measured at KDHE stations Smoky Hill River at Salina (SC/SB268), Enterprise (SC/SB265), and Junction City (SC/SB264). These endpoints will be evaluated periodically as phosphorus levels decline in the watershed, with achievement of the ALUS Index endpoint indicating the restored status of the aquatic life use in the river. Simultaneous achievement of the DO, DO saturation, pH, and chlorophyll-*a* endpoints will signal that TP reductions are addressing the accelerated succession of aquatic biota and the development of objectionable concentrations of algae and algae by-products, thereby restoring the domestic water supply and contact recreation uses in the river. After the endpoints are attained, simultaneous digression of these endpoints more than once every three years on average constitutes a resumption of the TP impairment at the respective station unless the TP impairment is delisted through the 303(d) process.

This TMDL seeks to establish an adaptive management approach for TP by establishing phased TP milestones (**Table 14**). The Phase I milestone will be a TP concentration of 0.210 mg/L, reflecting the 50th percentile of medians for KDHE SC stations within the Level III Ecoregion Central Great Plains. Total phosphorus concentrations approaching the Phase I milestone will cue the examination for altered, improved biological conditions at SB stations within the Smoky Hill River. Should aquatic life not respond, a Phase II milestone will commence with a TP concentration of 0.131 mg/L, reflecting the 25th percentile of medians for KDHE SC stations within the Level III Ecoregion Central Great Plains. The Phase II TP milestone is further supported by the current median TP concentration of 0.131 mg/L at the upstream, unimpaired station at Mentor (SC514).

Table 14. Current total phosphorus (TP) condition from 2000 to 2017 and Phase I and II TP milestones for the Smoky Hill River from Mentor to Junction City.

Station	Current Condition (2000-2017)	Phase I		Phase II	
	Median TP (mg/L)	TP Milestone (mg/L)	TP Reduction (%)	TP Milestone (mg/L)	TP Reduction (%)
Mentor (SC514)	0.131	0.131	0	0.131	0
Salina (SC268)	0.387	0.210	46	0.131	66
Enterprise (SC265)	0.327	0.210	36	0.131	60
Junction City (SC264)	0.507	0.210	59	0.131	74

3. SOURCE INVENTORY AND ASSESSMENT

The Smoky Hill River TMDL Watershed is comprised of the Salina (SC268), Enterprise (SC265), and Junction City (SC264) watersheds. These watersheds predominantly lie within Saline, Dickinson, and Geary counties. Within this section, point sources, livestock, land use, population, on-site waste systems, and contributing runoff are considered by watershed and county.

Point Sources

There are a total of 20 National Pollution Discharge Elimination System (NPDES) permitted facilities within the Smoky Hill River TMDL Watershed (**Tables 15-16**). Of the 20 permitted facilities, seven discharge to the Smoky Hill River near Salina (SC268) Watershed, two discharge to the Smoky Hill River at Enterprise (SC265) Watershed, and 11 discharge to the Smoky Hill River at Junction City (SC264) Watershed. Additionally, there are two Municipal Separate Storm Sewer System (MS4) permits within the Smoky Hill River TMDL Watershed.

Dischargers to the Smoky Hill River near Salina (SC268) Watershed

There are a total of seven NPDES permitted facilities within the Smoky Hill River near Salina (SC268) Watershed (**Figure 2**). Of the seven permitted facilities, one is a non-discharging lagoon, one is an industrial quarry pit dewatering facility, two are municipal discharging lagoons, two are facilities implementing groundwater remediation, and one is a municipal mechanical WWTP.

The non-discharging lagoon within the watershed is operated by Falun Improvement District. It is a two-cell lagoon that is prohibited from discharging. This system does not monitor for TP and is not expected to contribute to the TP impairment in the watershed.

The industrial quarry pit dewatering facility within the watershed is operated by Buildex, Inc. (Shale Quarry-Marquette), a shale mining company. This facility has three outfalls, two of which discharge from shale dewatering pits that are also used to retain stormwater runoff; the

third outfall is inactive as of 2016, when the company built a berm. As of the 2016 inspection, Buildex, Inc. (Shale Quarry-Marquette) has not discharged to Dry Creek. This system does not monitor for TP and is not expected to contribute to the TP impairment in the watershed.

The two municipal discharging lagoons within the watershed are operated by the City of Assaria and the City of Smolan. Both facilities treat domestic waste in a three-cell lagoon system. Previously, the City of Smolan operated a non-discharging lagoon, but this facility was upgraded to a discharging lagoon in 2011. Both facilities are required to monitor for TP quarterly, when discharging; however, they are currently not required to report the discharge volume. According to the facility's Discharge Monitoring Report (DMR) period of record (September 2004 to December 2017), the City of Assaria discharged to the Smoky Hill River during approximately 55% of the quarters, but has not discharged since the first quarter of 2014. According to the facility's DMR period of record (May 2013 to September 2017), the City of Smolan discharged to Dry Creek via an unnamed tributary during approximately 44% of the quarters. The discharging lagoons for the City of Assaria and the City of Smolan will be assigned a TP wasteload allocation (WLA) under this TMDL.

The two facilities implementing groundwater remediation are Smolan Pork Site Groundwater Remediation and Matador Cattle Company. Smolan Pork Site Groundwater Remediation is removing tetrachloride and ethylene dibromide from five wells with an air stripper and filter before discharging to a tributary of Dry Creek. According to the facility's DMR period of record (May 2013 to November 2017), the facility discharged 0.056 million gallons per day (MGD). This facility monitors annually for TP and has collected data from 2014 to 2017; during this time, it discharged a flow weighted mean of 0.115 mg/L TP. In total, the facility discharged 0.054 pounds per day (lbs/day) TP. Matador Cattle Company is removing volatile organic compounds from three separate wells with an air stripper. A sequestrant is added prior to treatment with the air stripper and groundwater is discharged through two outfalls to the former Smoky Hill River bed in Salina. According to the facility's DMR period of record (December 2010 to September 2017), outfall 001A1 discharged 0.093 MGD and outfall 002A1 discharged 0.29 MGD, totaling 0.383 MGD. This facility monitored yearly for TP at both outfalls from 2011 to 2015; during this time, it discharged a mean of 0.554 mg/L TP at the first outfall and 0.408 mg/L TP at the second outfall. The flow-weighted TP concentration of this facility's discharge is 0.534 mg/L. In total, the facility discharged 1.71 lbs/day. The facility is no longer required to monitor for TP. The Smolan Pork Site Groundwater Remediation and Matador Cattle Company are assigned TP WLAs under this TMDL.

The municipal mechanical WWTP within the watershed is operated by the City of Salina. According to the facility's DMR period of record (January 2003 to November 2017), this facility currently operates at 4.2 MGD, making it the largest discharger to the Smoky Hill River. The WWTP is designed for nutrient removal via activated sludge. Additionally, the facility is allowed to use reclaimed wastewater effluent for irrigating a golf course, allowing nutrient rich waters to be utilized more efficiently. Currently, the City of Salina WWTP has a monthly monitoring requirement for TP. From 2003 to 2017, the discharge from this facility has a mean

TP concentration of 3.82 mg/L, or 134 lbs/day. The City of Salina WWTP is assigned a TP WLA under this TMDL.

Dischargers to the Smoky Hill River at Enterprise (SC265) Watershed

There are a total of two NPDES permitted facilities within the Smoky Hill River at Enterprise (SC265) Watershed (**Figure 3**). Of the two permitted facilities, one is a facility operating a groundwater remediation process and one is a municipal mechanical WWTP.

The facility implementing groundwater remediation is Country Club Acres. This facility is remediating a groundwater plume for grain fumigants from the nearby Scoular Elevator. It operates five wells that are treated with an air stripper, bag filter, and activated carbon filter before discharging to East Dry Creek. Prior to treatment with the air stripper, an antiscalant chemical is added. According to the facility's DMR period of record (April 2014), this facility has a mean discharge of 0.035 MGD. It is not required to monitor for TP. Country Club Acres is assigned a TP WLA under this TMDL to account for nominal loading within the watershed.

The municipal mechanical WWTP within the watershed is operated by the City of Abilene. According to the facility's DMR period of record (May 2008 to December 2017), this facility currently operates at 0.6 MGD. The WWTP is designed for nutrient removal utilizing aerobic digestion and discharges to the Smoky Hill River. Currently, the City of Abilene WWTP has a monthly monitoring requirement for TP. From 2008 to 2017, the discharge from this facility has a mean TP concentration of 2.39 mg/L, or 12 lbs/day. The City of Abilene WWTP is assigned a TP WLA under this TMDL.

Dischargers to the Smoky Hill River at Junction City (SC264) Watershed

There are a total of 11 NPDES permitted facilities within the Smoky Hill River at Junction City (SC264) Watershed (**Figure 4**). Of the 11 permitted facilities, two are non-discharging lagoons, five are industrial pit dewatering facilities, two are municipal discharging lagoons, and two are municipal mechanical WWTPs.

The two non-discharging lagoons within the watershed are Dickinson County Sewer District #3 – Detroit and M & M Mobile Home Court 2. Both facilities are two-cell lagoons that are prohibited from discharging. These systems do not monitor for TP and are not expected to contribute to the TP impairment in the watershed.

The five industrial pit dewatering facilities within the watershed are: Penny's Concrete – Smoky Hill Plant; N.R. Hamm Quarry, Inc. – Kelly Quarry #95; Bayer Construction Company, Inc. – KS Falls South Quarry; Bayer Construction Company, Inc. – KS Falls North Quarry; and Bayer Construction Company, Inc. – KS Falls Poland Quarry. Penny's Concrete – Smoky Hill Plant is a ready-mix dry batch concrete plant that generates wastewater from washing concrete equipment. Washwater is retained in a four-cell settling basin and recycled for washing. The four remaining industrial discharging lagoons within the watershed are limestone quarries that generate wastewater from washing and crushing limestone. Washwater from settling ponds and

dewatering pits are the only source of discharge from these facilities. None of these facilities monitor for TP and they are not expected to contribute to the TP impairment in the watershed.

The two municipal discharging lagoons within the watershed are operated by the City of Enterprise and the City of Grandview Plaza. Both facilities treat domestic waste in a three-cell lagoon system. They are required to collect and report TP monthly, when discharging. According to the facility's DMR period of record (September 2004 to December 2017), the City of Enterprise discharges a mean of 0.056 MGD to the Smoky Hill River, with a mean TP concentration of 4.13 mg/L, or 1.93 lbs/day. The City of Grandview Plaza discharges to Frank's Creek, but there have not been any reported discharges. The discharging lagoons for the City of Enterprise and the City of Grandview Plaza are assigned TP WLAs under this TMDL.

The two municipal mechanical WWTPs within the watershed are the City of Chapman WWTP and the City of Junction City WWTP (Southwest Plant). According to the facility's DMR period of record (September 2004 to November 2017), the City of Chapman WWTP currently operates at 0.18 MGD. The WWTP is not designed for nutrient removal. Currently, the City of Chapman WWTP has a monthly monitoring requirement for TP. From 2004 to 2017, the discharge from this facility has a mean TP concentration of 3.92 mg/L, or 5.89 lbs/day. According to the facility's DMR period of record (January 2011 to December 2017), the City of Junction City WWTP (Southwest Plant) currently operates at 0.88 MGD. The WWTP is designed for nutrient removal utilizing activated sludge and has seen a drastic decrease in effluent TP concentration since altering its operation in 2010. Currently, the City of Junction City WWTP (Southwest Plant) has a monthly monitoring requirement for TP. Prior to 2011, the mean TP concentration was 47.7 mg/L. From 2011 to 2017, the discharge from this facility has a mean TP concentration of 3.79 mg/L, or 27.9 lbs/day. The City of Chapman WWTP and the City of Junction City WWTP (Southwest Plant) are assigned TP WLAs under this TMDL.

Table 15. National Pollution Discharge Elimination System (NPDES) facilities in the Smoky Hill River TMDL Watershed.

Permittee	Kansas Permit Number	NPDES Permit Number	Facility Type	Receiving Stream	Permit Expiration	Monitoring Frequency	Current Flow (MGD)	Current Total Phosphorus Mean (mg/L)
<i>Salina (SC268)</i>								
Falun Improvement District	M-SH51-NO01	KSJ000298	Non-discharging lagoon	NA	05/31/2020	NA	0	NA
Buildex Inc. (Shale Quarry-Marquette)	I-SH25-PO01	KS0095524	Industrial quarry pit dewatering	Dry Creek	12/31/2019	NA	—	—
City of Assaria	M-SH02-OO01	KS0082295	Municipal discharging lagoon	Smoky Hill River	09/30/2019	Quarterly	—	—
City of Smolan	M-SH36-OO01	KS0099317	Municipal discharging lagoon	Dry Creek	12/31/2021	Quarterly	—	—

Permittee	Kansas Permit Number	NPDES Permit Number	Facility Type	Receiving Stream	Permit Expiration	Monitoring Frequency	Current Flow (MGD)	Current Total Phosphorus Mean (mg/L)
<i>Salina (SC268; continued)</i>								
Smolan Pork Site Groundwater Remediation	I-SH36-PO01	KS0100404	Industrial groundwater remediation	Dry Creek	10/31/2022	Annually	0.056	0.115
Matador Cattle Company	I-SH33-PO12	KS0099996	Industrial groundwater remediation	Former Smoky Hill River Channel	10/31/2020	NA	0.383	0.534
City of Salina	M-SH33-IO01	KS0038474	Municipal mechanical wastewater treatment plant	Smoky Hill River	12/31/2019	Monthly	4.2	3.82
<i>Enterprise (SC265)</i>								
Country Club Acres - Scouler Elevator - NE Groundwater Remediation Project	I-SH33-PO11	KS0098809	Industrial groundwater remediation	East Dry Creek	4/30/2019	NA	0.035	–
City of Abilene	M-SH01-OO02	KS0098647	Municipal mechanical wastewater treatment plant	Smoky Hill River	12/31/2019	Monthly	0.60	2.39
<i>Junction City (SC264)</i>								
Dickinson County Sewer District #3 - Detroit	M-SH54-NO01	KSJ000667	Non-discharging lagoon	NA	10/31/2022	NA	0	NA
M & M Mobile Home Court 2	C-SH04-NO01	KSJ000541	Non-discharging lagoon	NA	05/31/2020	NA	0	NA
Penny's Concrete - Smoky Hill Plant	I-SH45-PR02	KSG110179	Concrete operation pit dewatering	Goose Creek	09/30/2017	NA	–	–
N.R. Hamm Quarry, Inc. - Kelly Quarry #95	I-SH04-PO05	KS0093955	Industrial quarry pit dewatering	Smoky Hill River	06/30/2019	NA	–	–
Bayer Construction Company, Inc. - KS Falls South Quarry	I-SH04-PO07	KS0097756	Industrial quarry pit dewatering	Smoky Hill River	12/31/2019	NA	–	–

Permittee	Kansas Permit Number	NPDES Permit Number	Facility Type	Receiving Stream	Permit Expiration	Monitoring Frequency	Current Flow (MGD)	Current Total Phosphorus Mean (mg/L)
<i>Junction City (SC264; continued)</i>								
Bayer Construction Company, Inc. - KS Falls North Quarry	I-SH04-PO02	KS0001813	Industrial quarry pit dewatering	Smoky Hill River	12/31/2019	NA	–	–
Bayer Construction Company, Inc. - KS Falls Poland Quarry	I-SH45-PO02	KS0098116	Industrial quarry pit dewatering	Smoky Hill River	12/31/2019	NA	–	–
City of Enterprise	M-SH08-OO01	KS0027502	Municipal discharging lagoon	Smoky Hill River	02/28/2019	Monthly	0.056	4.13
City of Grandview Plaza	M-SH13-OO01	KS0116521	Municipal discharging lagoon	Frank's Creek	03/31/2019	Monthly	–	–
City of Chapman	M-SH04-OO01	KS0029114	Municipal mechanical wastewater treatment plant	Smoky Hill River	10/31/2019	Monthly	0.18	3.92
City of Junction City - Southwest Plant	M-SH45-OO02	KS0092151	Municipal mechanical wastewater treatment plant	Smoky Hill River	08/31/2019	Monthly	0.88	3.79

Definitions: NA – not applicable; * - not a condition of current permit; – - data not available

Table 16. Current poundage of daily discharged total phosphorous from relevant National Pollution Discharge Elimination System (NPDES) facilities in the Smoky Hill River TMDL Watershed.

Permittee	KS Permit Number	NPDES Permit Number	Facility Type	Current TP Load (lbs/day)
Smolan Pork Site Groundwater Remediation	I-SH36-PO01	KS0100404	Industrial groundwater remediation	0.05
Matador Cattle Company	I-SH33-PO12	KS0099996	Industrial groundwater remediation	1.71
City of Salina	M-SH33-IO01	KS0038474	Municipal mechanical wastewater treatment plant	134
City of Abilene	M-SH01-OO02	KS0098647	Municipal mechanical wastewater treatment plant	12.0
City of Enterprise	M-SH08-OO01	KS0027502	Municipal wastewater treatment plant	1.93
City of Chapman	M-SH04-OO01	KS0029114	Municipal mechanical wastewater treatment plant	5.89

Permittee	KS Permit Number	NPDES Permit Number	Facility Type	Current TP Load (lbs/day)
City of Junction City - Southwest Plant	M-SH45-OO02	KS0092151	Municipal wastewater treatment plant	27.9

Major Municipal Point Source Dischargers

The analyses in Section 2 indicate that there are dominant point sources contributing to TP loads in the Smoky Hill River from Mentor to Junction City. The major point sources contributing to this watershed are: the City of Salina WWTP, upstream of Salina (SC268; **Figure 49**); the City of Abilene WWTP, upstream of Enterprise (SC265; **Figure 50**); and the City of Junction City WWTP (Southwest Plant), upstream of Junction City (SC264; **Figure 51**). The influence of these WWTPs' effluents was evaluated by comparing the monthly TP concentrations in the WWTP effluent to the monthly TP concentrations at their respective Smoky Hill River stations, where concomitant data were available. In each instance, increases and decreases in TP concentrations in WWTP effluent typically correspond to a likewise response in TP concentrations within the Smoky Hill River.

Figure 49. Total phosphorus in effluent from Salina Wastewater Treatment Plant (NPDES Permit # KS0038474) contributed to the Smoky Hill River near Salina (SC268), February 2003 to September 2017.

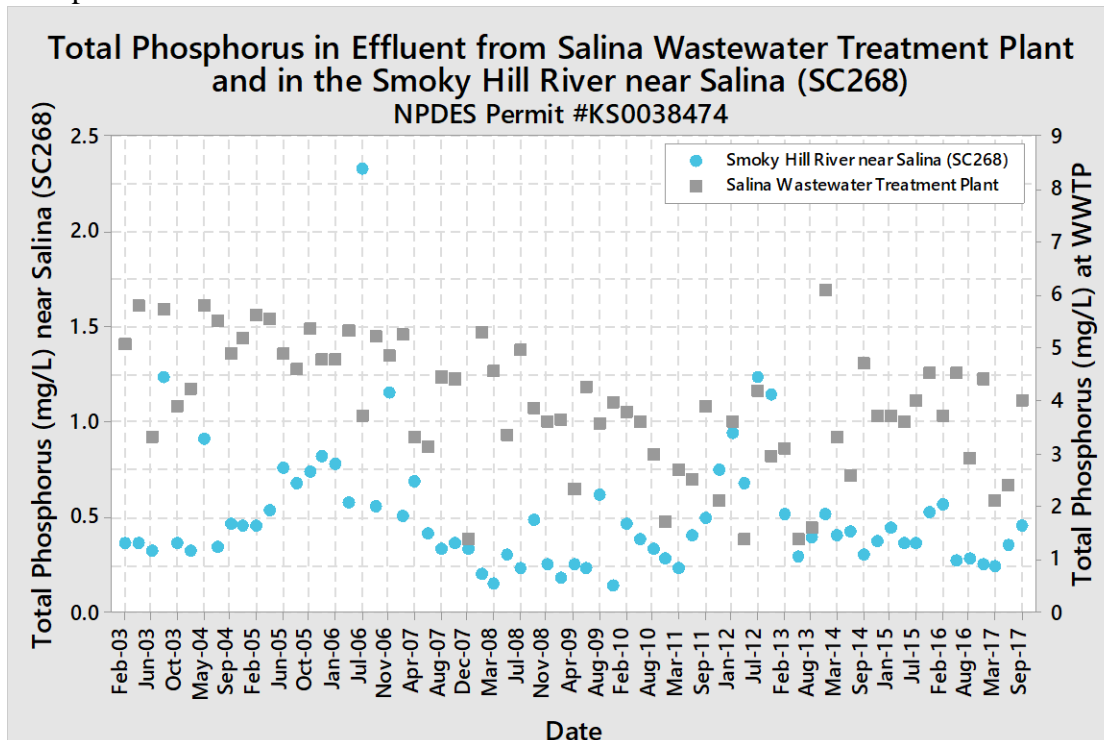


Figure 50. Total phosphorus in effluent from Abilene Wastewater Treatment Plant (NPDES Permit # KS0098647) contributed to the Smoky Hill River at Enterprise (SC265), May 2008 to September 2017.

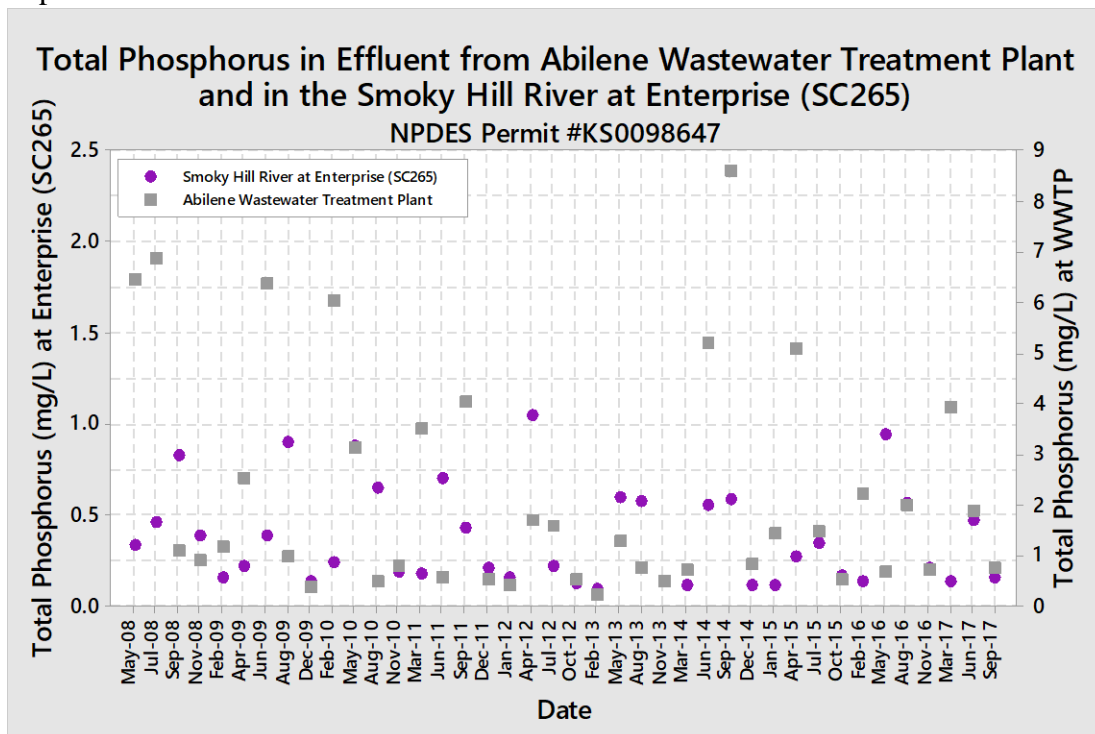
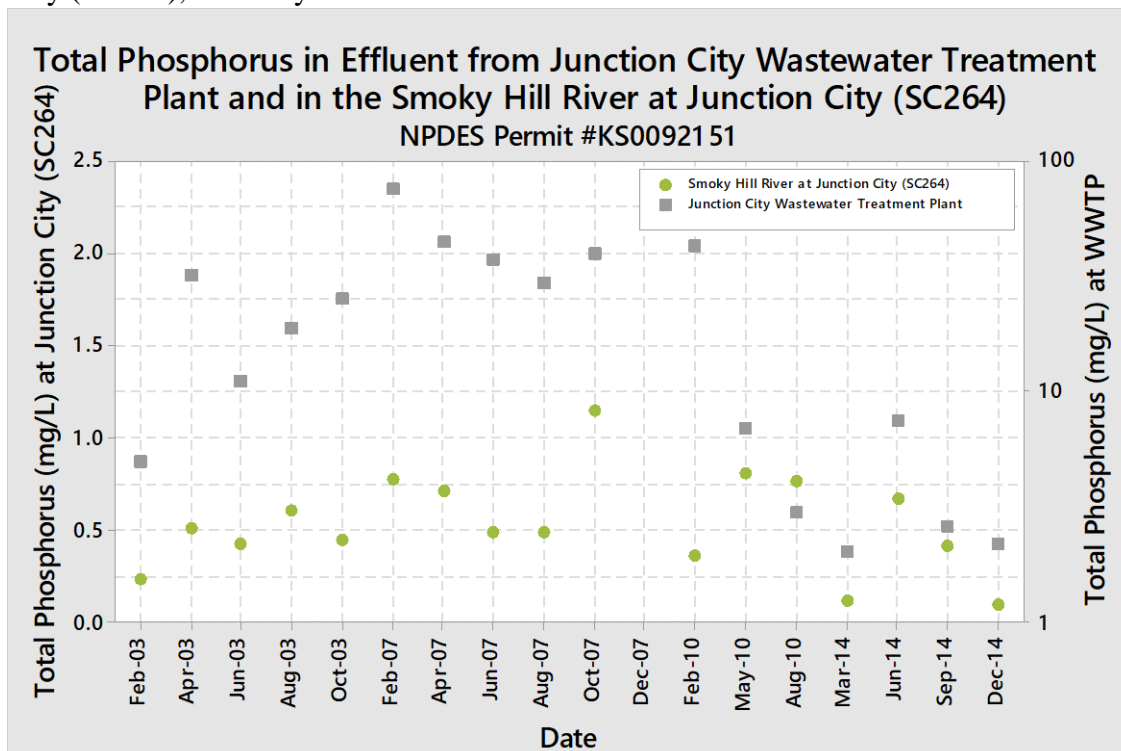


Figure 51. Total phosphorus in effluent from Junction City Wastewater Treatment Plant (Southwest Plant; NPDES Permit # KS0092151) contributed to the Smoky Hill River at Junction City (SC264), February 2003 to December 2014.



Municipal Separate Storm Sewer System Dischargers

There are two MS4 permits within the Smoky Hill River TMDL Watershed (**Table 17**). These permits authorize the City of Salina to discharge stormwater to the Salina (SC268) Watershed and the City of Junction City to discharge stormwater to the Junction City (SC264) Watershed. Under this permit, the cities are expected to develop Stormwater Management Plans (SMPs) and implement Best Management Practices (BMPs), to the Maximum Extent Practicable, within their jurisdictions in order to reduce pollutant loading to waterbodies during rainfall events.

Table 17. National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System permits in the Smoky Hill River TMDL Watershed.

Permittee	Kansas Permit Number	NPDES Permit Number	Permit Expiration
City of Salina	M-SH33-SN01	KSR440018	01/31/2019
City of Junction City	M-LR15-SN01	KSR440010	01/31/2019

Livestock and Waste Management Systems

There are 41 certified or permitted Animal Feeding Operations (AFOs) and Concentrated Animal Feeding Operations (CAFOs) within the Smoky Hill River TMDL Watershed. Of these, 18 are located in the Salina (SC268) Watershed, 13 are located in the Enterprise (SC265) Watershed, and 10 are located in the Junction City (SC264) Watershed (**Figures 2-4; Table 18**). There are three CAFOs large enough to require a federal permit (A-SASA-HO01, A-SHMP-CO02, and A-SHSA-CO01), all of which are located in the Salina (SC268) Watershed.

All of these livestock facilities have waste management systems designed to retain an anticipated two weeks of normal wastewater from their operations and contain a 25-year, 24-hour rainfall/runoff event, as well. Typically, this rainfall event coincides with streamflow that occurs less than 1-5% of the time. Additionally, facility waste management systems are designed to minimize runoff entering operations and detain runoff emanating from operations. It is unlikely TP loading would be attributable to properly operating permitted facilities, though extensive loading may occur if any of these facilities were in violation and discharged. No livestock facilities within the watershed are permitted to discharge and all are therefore assigned a WLA of 0 lbs/day.

Table 18. Certified or permitted Animal Feeding Operations and Concentrated Animal Feeding Operations in the Smoky Hill River TMDL Watershed.

Kansas Permit Number	County	Livestock Type	Livestock Total
<i>Salina (SC268)</i>			
A-SAMP-BA01	McPherson	Beef	100
A-SASA-BA01	Saline	Beef	300
A-SASA-BA10	Saline	Beef	150
A-SASA-BA12	Saline	Beef	300
A-SASA-BA13	Saline	Beef	300
A-SASA-HO01	Saline	Swine	20,568
A-SHMP-BA08	McPherson	Beef	40
A-SHMP-CO02	McPherson	Beef	2,000

Kansas Permit Number	County	Livestock Type	Livestock Total
<i>Salina (SC268; continued)</i>			
A-SHSA-BA01	Saline	Beef	598
A-SHSA-BA05	Saline	Beef	300
A-SHSA-BA17	Saline	Beef	200
A-SHSA-BO06	Saline	Beef	250
A-SHSA-BO07	Saline	Beef	750
A-SHSA-BO08	Saline	Beef	300
A-SHSA-BO09	Saline	Beef	299
A-SHSA-BO10	Saline	Beef	998
A-SHSA-CO01	Saline	Beef	9,000
A-SHSA-MO06	Saline	Dairy	180
<i>Enterprise (SC265)</i>			
A-SHDK-BA03	Dickinson	Beef	600
A-SHDK-BA23	Dickinson	Beef	250
A-SHDK-BA31	Dickinson	Beef	300
A-SHDK-BA50	Dickinson	Beef	100
A-SHDK-BA54	Dickinson	Beef	80
A-SHDK-BA59	Dickinson	Beef	299
A-SHDK-BO13	Dickinson	Beef	950
A-SHDK-BO17	Dickinson	Beef	990
A-SHDK-BO31	Dickinson	Beef	760
A-SHDK-MA04	Dickinson	Dairy	50
A-SHDK-PA01	Dickinson	Poultry	20,000
A-SHSA-BA02	Saline	Beef	80
A-SHSA-BA03	Saline	Beef	100
<i>Junction City (SC264)</i>			
A-SHDK-BA12	Dickinson	Beef	870
A-SHDK-BA40	Dickinson	Beef	300
A-SHDK-BA48	Dickinson	Beef	40
A-SHDK-BA49	Dickinson	Beef	70
A-SHDK-BA53	Dickinson	Beef	600
A-SHDK-BO12	Dickinson	Beef	999
A-SHDK-SA02	Dickinson	Swine	1,000
A-SHGE-BA01	Geary	Beef	120
A-SHGE-SA01	Geary	Swine	30
N-SHDK-6966*	Dickinson	Beef	140

Definitions: **Federal Permit**; * - application pending

The total number of livestock within Saline, Dickinson, and Geary counties is approximately 120,000 head (**Table 19**; U.S. Department of Agriculture, 2012). The primary livestock industry in all counties is cattle, with cattle and calves numbering approximately: 24,600 in Saline County; 68,900 in Dickinson County; and 13,300 in Geary County. From 2007 to 2012, cattle and calves have declined in Saline and Dickinson counties by 29% and 10%, respectively, while

cattle and calves have increased by 4% in Geary County. Overall, sheep and lambs and poultry are increasing in the counties, though there is an overall decline in livestock of 18%.

Table 19. Agricultural census results for livestock by county from 2007 and 2012 (U.S. Department of Agriculture, 2012).

Livestock	Total, 2007	Total, 2012	Percent Change
<i>Saline County</i>			
Cattle and Calves	34,581	24,578	-29
Sheep and Lambs	2,020	2,123	5
Poultry	1,842	1,188	-36
Hogs and Pigs	806	322	-60
Goats	678	569	-16
<i>Dickinson County</i>			
Cattle and Calves	76,813	68,864	-10
Sheep and Lambs	1,746	4,115	136
Poultry	571	1,029	80
Hogs and Pigs	13,244	1,496	-89
Goats	550	761	38
<i>Geary County</i>			
Cattle and Calves	12,810	13,304	4
Sheep and Lambs	85	537	532
Poultry	163	546	235
Hogs and Pigs	NA	NA	NA
Goats	196	289	47
Total	146,105	119,721	-18

Definitions: NA - not available

Land Use

Saline, Dickinson, and Geary counties have an approximate total of 1,900 farms and 1,020,000 acres of cropland (**Table 20**; U.S. Department of Agriculture, 2012). Of the three counties, Dickinson County contains the largest number of farms and the greatest acreage of cropland. Overall, there is a trend of declining numbers of farms and acres in cropland of 5 and 9%, respectively.

The 2011 National Land Cover Database indicates the dominant land use in the watershed is cultivated crops, with 43% of the watershed currently used for crop cultivation (**Figure 52**; **Table 21**). Cultivated cropland has an increased potential for nutrient runoff from fertilizers, which can contribute to TP loads in the watershed. Grassland, including pastureland and hay fields, is the second most prevalent land use in the watershed, with 39% of the watershed in grassland. Additionally, 9% of the watershed is developed, with the most development occurring in the Salina (SC268) Watershed (11%). Built infrastructure and impervious surfaces in urban environments increase runoff, which can potentially contribute to TP loads in the watershed, as well.

Table 20. Agricultural census results for farms and cropland by county from 2007 and 2012 (U.S. Department of Agriculture, 2012).

County	Year	Total Farms in Cropland	Total Cropland (acres)
Saline	2007	749	431,209
	2012	674	364,468
	Percent Change	-10	-15
Dickinson	2007	1,046	536,885
	2012	1,011	510,193
	Percent Change	-3	-5
Geary	2007	229	148,465
	2012	238	145,694
	Percent Change	4	-2
Total	2007	2,024	1,116,559
	2012	1,923	1,020,355
	Percent Change	-5	-9

Figure 52. The 2011 National Land Cover Database map for land cover in the Smoky Hill River TMDL Watershed.

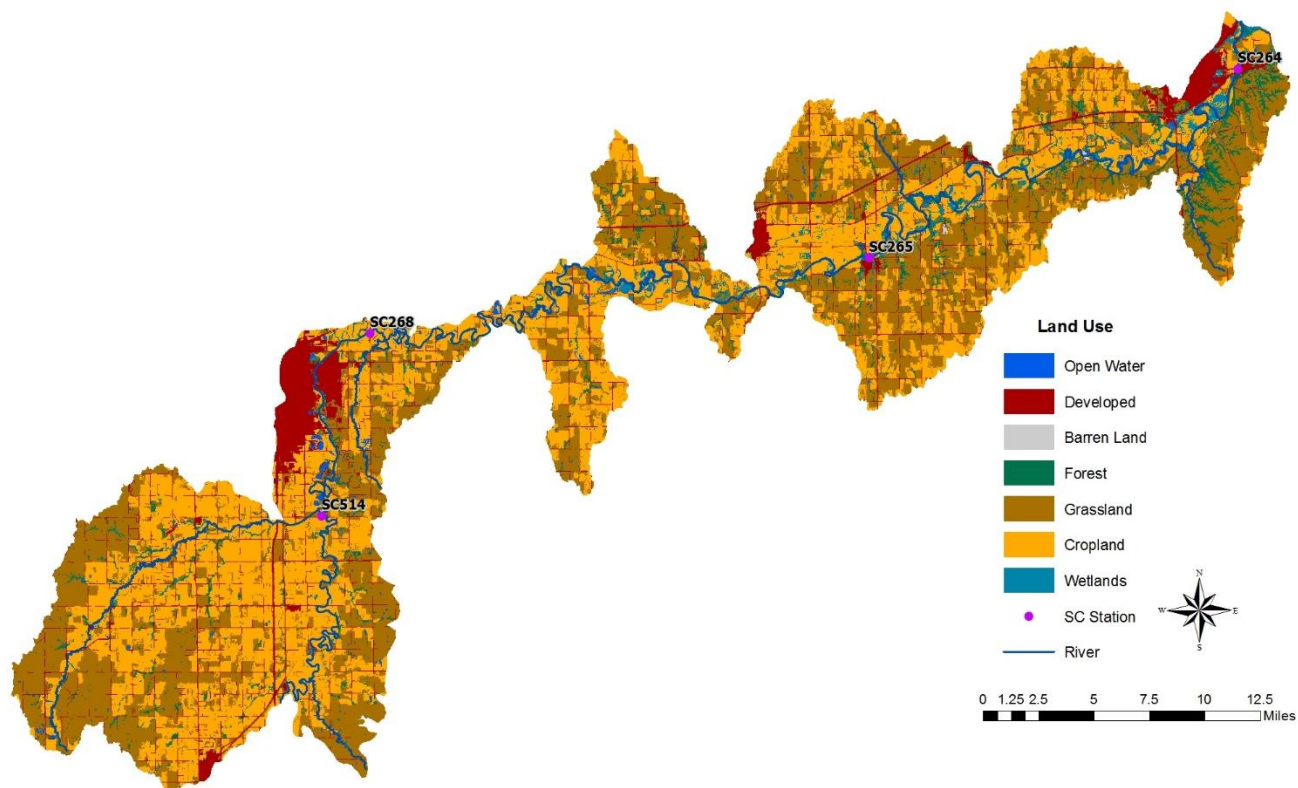


Table 21. Data from the 2011 National Land Cover Database for land cover by percent in the Smoky Hill River TMDL Watershed.

Station	Land Cover (%)						
	Open Water	Developed	Barren	Forest	Grassland	Cultivated Crops	Wetlands
Salina (SC268)	1	11	0	3	36	48	1
Enterprise (SC265)	3	6	0	4	38	47	2
Junction City (SC264)	2	8	0	7	45	34	4
Total	2	9	0	5	39	43	2

Population Density

According to the 2010 U.S. Census, Saline County has a population of approximately 55,600 and has grown by 4% since 2000 (**Table 22**). This portion of the watershed encompasses the cities of Assaria, Salina, and Smolan. Of these, the City of Salina is the largest urban center and is the only city that experienced population growth. The City of Salina has a population of approximately 47,700 as of 2010, and the Kansas Water Office projects the population to increase by approximately 11,000 by 2040. Dickinson County has a population of approximately 19,800 as of 2010 and has grown by 2% since 2000. The cities within this portion of the watershed are Abilene, Chapman, Detroit, and Enterprise. Of these, the City of Abilene is the largest urban center with a population of approximately 6,800 and a projected population increase of approximately 3,800 by 2040. All cities within the watershed have increased in population from 2000 to 2010 and are projected to continue this growth. Geary County has a population of approximately 34,400 as of 2010 and has grown by 23% since 2000. The cities within this portion of the watershed are Grandview Plaza and Junction City. Of these, the City of Junction City is the largest urban center with an approximate population of 23,400 and a projected population increase of approximately 1,500 by 2040.

Table 22. City and county census results from 2000 and 2010 (U.S. Census Bureau, 2010) and population projections for 2040 (Kansas Water Office, 2002).

Location	Population, 2000	Population, 2010	Population Projection, 2040	Population Change, 2000 to 2010 (%)
City of Assaria	438	413	426	-6
City of Salina	45,679	47,707	58,790	4
City of Smolan	218	215	246	-1
Saline County	53,597	55,606	67,287	4
City of Abilene	6,543	6,844	10,634	5
City of Chapman	1,241	1,393	1,868	12
City of Detroit	—	114	—	—
City of Enterprise	836	855	1,306	2
Dickinson County	19,344	19,754	25,833	2
City of Grandview Plaza	1,184	1,560	1,447	32
City of Junction City	18,886	23,353	24,841	24
Geary County	27,947	34,362	34,852	23

Definition: — no data

On-Site Waste Systems

The populations of Saline and Geary counties are predominantly urban, with 85% and 88%, respectively, of their populations classified as urban (**Table 23**). The population of Dickinson County is predominantly rural, with 64% of the county classified as rural. Urban populations are typically served by municipal sewer systems; however, rural populations do not have access to this service and use septic systems. According to the U.S. Environmental Protection Agency's Spreadsheet Tool for Estimating Pollutant Load (STEPL), there are a total of 1,573 septic systems located in the Smoky Hill River TMDL Watershed. Septic systems in the state of Kansas typically have an estimated 10-15% failure rate (Electric Power Research Institute provided by U.S. Environmental Protection Agency, 2017). Failing on-site septic systems have the potential to contribute to nutrient loading in the watershed. However, because of their small flows and the proclivity of phosphorus to adsorb to soil, failing on-site septic systems are considered a minor source of TP loading within the watershed and are not expected to significantly contribute to TP impairment in the Smoky Hill River.

Table 23. Census results by urban and rural population and county from 2010 (U.S. Census Bureau, 2010).

County	Classification	Population, 2010	Percent
Saline	Urban	47,493	85
	Rural	8,113	15
Dickinson	Urban	7054	36
	Rural	12,700	64
Geary	Urban	30,351	88
	Rural	4,011	12

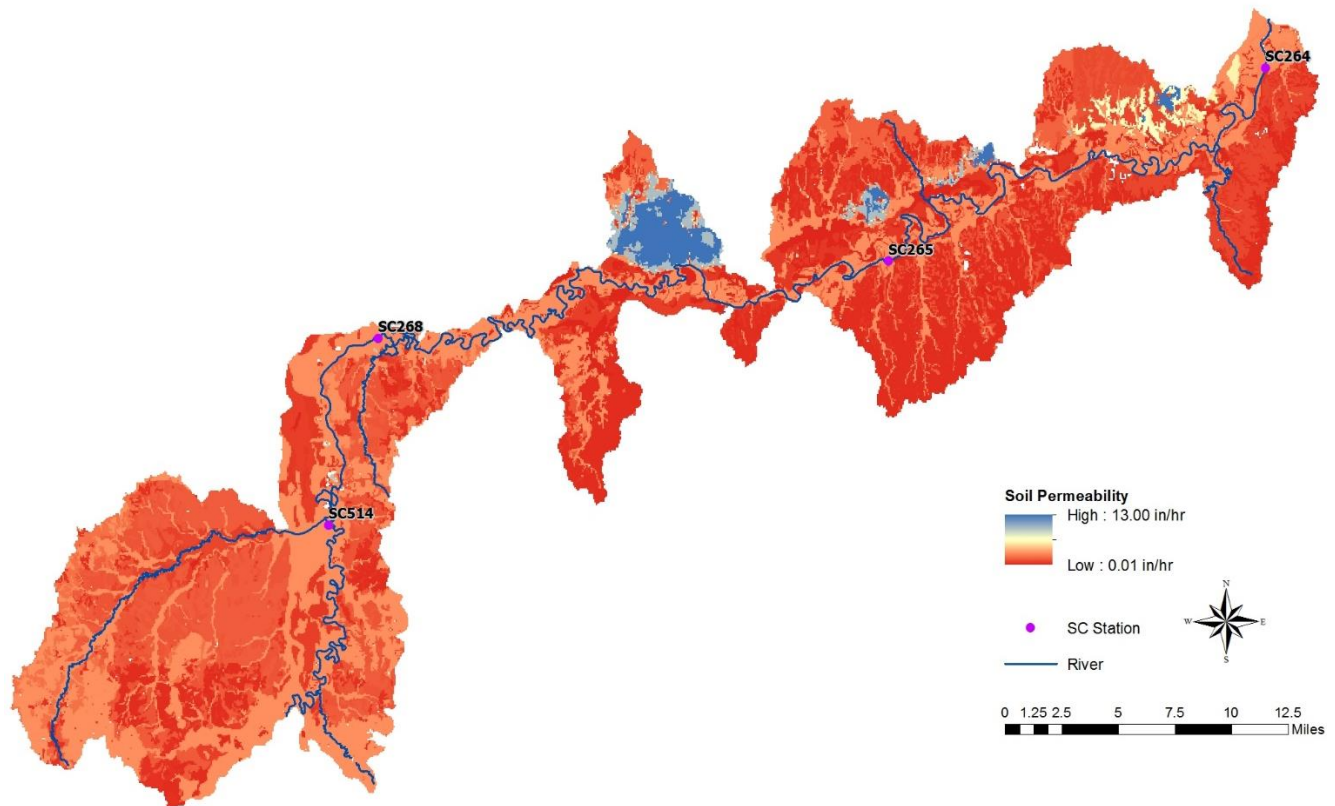
Contributing Runoff

Runoff conditions can occur as a result of either infiltration-excess (precipitation exceeds the infiltration rate of the soil) or saturation-excess (precipitation falls on soils saturated due to an elevated water table), causing overland flow (Juracek, 2000). Overland flow can impact the quality of water entering streams, thereby impacting water-quality loads. Soil permeability categories in Kansas have been defined by the following criteria in inches per hour (in/hr): very high (3.43 in/hr), high (2.86 in/hr), moderate (2.29 in/hr), low (1.71 in/hr), very low (1.14 in/hr), and extremely low (0.57 in/hr).

According to the Natural Resources Conservation Service (NRCS) State Soil Geographic Database (STATSGO), the Smoky Hill River TMDL Watershed has a soil permeability range of 0.01 to 13 in/hr (**Figure 53**). Within the watershed, 25% of the area has a soil permeability less than 1.14 in/hr. Overall, the watershed has a mean soil permeability of 1.01 in/hr, placing the overall watershed in the very low soil permeability category. Within the Salina (SC268) Watershed, 37% of the area has a soil permeability less than 1.14 in/hr; the watershed has a mean soil permeability of 0.84 in/hr, placing the watershed in the very low soil permeability category. Within the Enterprise (SC265) Watershed, 34% of the area has a soil permeability less than 1.71 in/hr; the watershed has a mean soil permeability of 1.58 in/hr, placing the watershed in the low

soil permeability category. Within the Junction City (SC264) Watershed, 30% of the area has a soil permeability less than 1.14 in/hr; the watershed has a mean soil permeability of 0.77 in/hr, placing the watershed in the very low soil permeability category.

Figure 53. Map of Natural Resources Conservation Service State Soil Geographic Database soil permeability in the Smoky Hill River TMDL Watershed.



Background Levels

Phosphorus is present over the landscape and in the soil profile. It is also present in terrestrial and aquatic biota. Wildlife can also contribute to phosphorus loadings, particularly if they congregate to a density that exceeds the assimilative capacity of the land or water.

4. ALLOCATION OF POLLUTANT REDUCTION RESPONSIBILITY

The following TMDLs, or load capacities (LC), are based upon the desired endpoints for aquatic life condition, dissolved oxygen concentration, dissolved oxygen saturation, pH, and chlorophyll-*a* concentration. All of these endpoints should improve to a level that provides full attainment of designated uses as phosphorus concentrations decrease in the Smoky Hill River.

Load Capacity

These TMDLs are established in two phases to reduce TP concentrations and loadings within the river and will require periodic assessment of aquatic life conditions to determine compliance with the narrative nutrient criteria as TP concentrations and loadings decline. The Phase I TP milestone is set at 0.210 mg/L, which is the 50th percentile of the median concentrations of KDHE SC stations within the Level III Ecoregion Central Great Plains. Presuming one or more of the endpoints are not met at the end of Phase I, Phase II will commence with a TP milestone of 0.131 mg/L, which is the 25th percentile of the median concentrations of KDHE SC stations within the Level III Ecoregion Central Great Plains. Further reductions in TP concentrations and loads for Phase II will be accomplished through enhanced implementation of controls of both point and nonpoint sources in the watershed. For both Phase I and Phase II, total LCs are calculated according to the previously described TP milestones and the flow conditions in the Smoky Hill River.

For purposes of comparing current TP loading conditions in the river to the expected reduction in TP loading, the current condition was evaluated using the median TP concentration at each SC station from 2000 to 2017. Sampled TP concentrations at all three stations were converted to loads for seasonal comparison with their respective TMDLs.

Wasteload Allocations

The total Phase I TP WLA for point sources in the Smoky Hill River TMDL Watershed is 103.3 lbs/day (**Table 24**). Under Phase II, the total TP WLA for point sources will be 55.9 lbs/day. Wasteload allocations are calculated for each facility according to the following: non-discharging lagoons, quarries, and concrete operations are calculated at 0 lbs/day; discharging lagoons are calculated at a TP concentration of 2 mg/L, an effluent concentration common in Kansas lagoons; groundwater remediation facilities are calculated at a TP concentration of 0.2 mg/L, if no TP concentration is reported, or at the facility's mean DMR TP concentration, if TP concentration is reported; Phase I municipal mechanical WWTP are calculated at a TP concentration of 1 mg/L; Phase II municipal mechanical WWTP are calculated at a TP concentration of 0.5 mg/L. The TP WLAs assigned to all permitted facilities are based upon current design flows for each facility, where available. Facilities with no design flow and reported discharge are assigned a design flow equal to their current discharge rate. Facilities with no design flow and no reported discharge are assigned a design flow of 0 MGD.

Salina (SC268) Watershed Wasteload Allocation

The two facilities assigned a Phase I and Phase II TP WLA concentration of 0 mg/L are the non-discharging lagoon Falun Improvement District and the quarry Buildex Inc. (Shale Quarry-Marquette). The Phase I and Phase II WLAs for the two discharging lagoon systems for the City of Assaria and the City of Smolan are calculated with the TP WLA concentration of 2 mg/L at design flow. Accordingly, the Phase I and Phase II TP WLA assigned to the City of Assaria lagoon is 1 lb/day, or 365 lbs/year. The Phase I and Phase II TP WLA assigned to the City of Smolan lagoon is 0.4 lb/day, or 146 lbs/year. The industrial groundwater remediation Phase I and Phase II WLA for the Smolan Pork Site Groundwater Remediation is calculated with the

current mean DMR reported TP WLA concentration of 0.1 mg/L at design flow. Accordingly, the Phase I and Phase II TP WLA assigned to this facility is 0.1 lbs/day, or 37 lbs/year. The industrial groundwater remediation Phase I and Phase II WLA for the Matador Cattle Company is calculated with the current mean DMR reported TP WLA concentration of 0.5 mg/L at design flow. Accordingly, the Phase I and Phase II TP WLA assigned to this facility is 2.4 lbs/day, or 876 lbs/year. The remaining facility within this watershed is the municipal mechanical WWTP operated by the City of Salina. This facility has a design flow of 7.25 MGD. The Phase I TP WLA concentration for this facility is 1 mg/L. Accordingly, the Phase I TP WLA assigned to this facility is 60.6 lbs/day, or 22,119 lbs/year; however, as this facility is currently designing a new WWTP, these loads are subject to change based upon the currently undetermined design flow of the new facility. The Phase II TP WLA concentration for this facility will be calculated at a concentration of 0.5 mg/L.

Enterprise (SC265) Watershed Wasteload Allocation

The industrial groundwater remediation WLA for Country Club Acres is calculated with a Phase I and Phase II TP WLA concentration of 0.2 mg/L at design flow. Accordingly, the Phase I and Phase II TP WLA assigned to this facility is 0.2 lbs/day, or 73 lbs/year. The remaining facility within this watershed is the municipal mechanical WWTP operated by the City of Abilene. The design flow for this facility is 1.3 MGD. The Phase I TP WLA concentration for this facility is a concentration of 1 mg/L. Accordingly, the Phase I TP WLA assigned to this facility is 10.9 lbs/day, or 3,979 lbs/year. The Phase II TP WLA concentration for this facility will be calculated at a concentration of 0.5 mg/L.

Junction City (SC264) Watershed Wasteload Allocation

The seven facilities assigned a Phase I and Phase II TP WLA concentration of 0 mg/L are: the non-discharging lagoons Dickinson County Sewer District #3 – Detroit and M & M Mobile Home Court 2; the concrete operation pit dewatering for Penny’s Concrete – Smoky Hill Plant; and the quarry pit dewatering for N.R. Hamm Quarry, Inc. – Kelly Quarry #95, Bayer Construction Company, Inc. – KS Falls South Quarry, Bayer Construction Company, Inc. – KS Falls North Quarry, and Bayer Construction Company, Inc. – KS Falls Poland Quarry. The WLAs for the two discharging lagoon systems for the City of Enterprise and the City of Grandview Plaza are calculated with a Phase I and Phase II TP WLA concentration of 2 mg/L at design flow. Accordingly, the Phase I and Phase II TP WLA assigned to the City of Enterprise lagoon is 1.5 lbs/day, or 548 lbs/year. The Phase I and Phase II TP WLA assigned to the City of Grandview Plaza lagoon is 3.2 lbs/day, or 1,168 lbs/year. The two remaining facilities within this watershed are the municipal mechanical WWTPs operated by the City of Chapman and the City of Junction City (Southwest Plant). The TP WLA is based upon the facilities’ design flows of 0.25 and 2.5 MGD, respectively. The Phase I TP WLA concentration for these facilities is 1 mg/L. Accordingly, the Phase I TP WLA assigned to the City of Chapman WWTP is 2.1 lbs/day, or 767 lbs/year. The Phase I TP WLA assigned to the City of Junction City WWTP (Southwest Plant) is 20.9 lbs/day, or 7,629 lbs/year. The Phase II TP WLA concentration for these facilities will be calculated at a concentration of 0.5 mg/L.

Table 24. Phase I total phosphorus wasteload allocations for National Pollution Discharge Elimination System (NPDES) permitted facilities in the Smoky Hill River TMDL Watershed.

Permittee	KS Permit Number	NPDES Permit Number	Facility Type	Design Flow (MGD)	Anticipated TP Wasteload Allocation Concentration (mg/L)	TP Daily Wasteload Allocation (lbs/day)	TP Annual Wasteload Allocation (lbs/year)
Falun Improvement District	M-SH51-NO01	KSJ000298	Non-discharging lagoon	0	NA	0	0
Buildex Inc. (Shale Quarry-Marquette)	I-SH25-PO01	KS0095524	Industrial quarry pit dewatering	—	0	0	0
City of Assaria	M-SH02-OO01	KS0082295	Municipal discharging lagoon	0.06	2	1.0	365
City of Smolan	M-SH36-OO01	KS0099317	Municipal discharging lagoon	0.024	2	0.4	146
Smolan Pork Site Groundwater Remediation	I-SH36-PO01	KS0100404	Industrial groundwater remediation	0.108	0.1	0.1	37
Matador Cattle Company	I-SH33-PO12	KS0099996	Industrial groundwater remediation	0.576	0.5	2.4	876
City of Salina	M-SH33-IO01	KS0038474	Municipal mechanical wastewater treatment plant	7.25	1	60.6	22,119
Total Phosphorus Wasteload Allocation near Salina (SC268)						64.5	23,543
Country Club Acres - Scoular Elevator - NE Groundwater Remediation Project	I-SH33-PO11	KS0098809	Industrial groundwater remediation	0.109	0.2	0.2	73
City of Abilene	M-SH01-OO02	KS0098647	Municipal mechanical wastewater treatment plant	1.3	1	10.9	3,979
Total Phosphorus Wasteload Allocation at Enterprise (SC265)						11.1	4,052
Dickinson County Sewer District #3 - Detroit	M-SH54-NO01	KSJ000667	Non-discharging lagoon	0	NA	0	0
M & M Mobile Home Court 2	C-SH04-NO01	KSJ000541	Non-discharging lagoon	0	NA	0	0
Penny's Concrete - Smoky Hill Plant	I-SH45-PR02	KSG110179	Concrete operation pit dewatering	—	0	0	0

Permittee	KS Permit Number	NPDES Permit Number	Facility Type	Design Flow (MGD)	Anticipated TP Wasteload Allocation Concentration (mg/L)	TP Daily Wasteload Allocation (lbs/day)	TP Annual Wasteload Allocation (lbs/year)
N.R. Hamm Quarry, Inc. - Kelly Quarry #95	I-SH04-PO05	KS0093955	Industrial quarry pit dewatering	—	0	0	0
Bayer Construction Company, Inc. - KS Falls South Quarry	I-SH04-PO07	KS0097756	Industrial quarry pit dewatering	—	0	0	0
Bayer Construction Company, Inc. - KS Falls North Quarry	I-SH04-PO02	KS0001813	Industrial quarry pit dewatering	—	0	0	0
Bayer Construction Company, Inc. - KS Falls Poland Quarry	I-SH45-PO02	KS0098116	Industrial quarry pit dewatering	—	0	0	0
City of Enterprise	M-SH08-OO01	KS0027502	Municipal discharging lagoon	0.091	2	1.5	548
City of Grandview Plaza	M-SH13-OO01	KS0116521	Municipal discharging lagoon	0.192	2	3.2	1168
City of Chapman	M-SH04-OO01	KS0029114	Municipal mechanical wastewater treatment plant	0.25	1	2.1	767
City of Junction City - Southwest Plant	M-SH45-OO02	KS0092151	Municipal mechanical wastewater treatment plant	2.5	1	20.9	7629
Total Phosphorus Wasteload Allocation at Junction City (SC264)						27.7	10,111
Total Phosphorus Total Reserve Wasteload Allocation						10.3	3,770
Total Phosphorus Total Wasteload Allocation						113.6	41,464

Definitions: NA - not applicable; — - no data

Reserve Wasteload Allocation

A reserve WLA is calculated at 10% for the entirety of the Smoky Hill River TMDL Watershed in order to accommodate future development within the watershed. The Phase I WLA is 103.3 lbs/day, resulting in a reserve WLA of 10.3 lbs/day. Reserve WLAs apply to the terminus of CUSEGA 102600081 (Smoky Hill River Segment 1), below Junction City, and may be apportioned throughout the Smoky Hill River Watershed from Mentor to Junction City.

Municipal Separate Storm Sewer System Wasteload and Reserve Wasteload Allocations

Within the Smoky Hill River TMDL Watershed, MS4 stormwater allocations are calculated for the Salina (SC268) and Junction City (SC264) watersheds. There are no permitted MS4 entities or allocations within the Enterprise (SC265) Watershed. Based upon modeling completed with

Wiki Watershed (Stroud Water Research Center, 2018), stormwater discharge was estimated for calculating the MS4 stormwater allocation. Estimated stormwater discharge, percent permittee development in the watershed, and percent of days with precipitation each year were used to calculate a daily TP load. The daily TP load was then divided by the LC remaining after accounting for WLAs and reserve WLAs for both Phase I and Phase II. The resulting value is expressed as a percentage and applied to the LC remaining after accounting for WLAs and reserve WLAs to calculate MS4 stormwater allocations. Additionally, reserve stormwater allocations are established to account for future development and nominal stormwater allocations are established from 50 to 100% flow exceedance.

The two MS4 permits in the Smoky Hill River TMDL Watershed are for the City of Salina, in the Salina (SC268) Watershed, and the City of Junction City, in the Junction City (SC264) Watershed. The Phase I TP MS4 stormwater allocation for the Salina (SC268) Watershed is 8%, with a reserve MS4 stormwater allocation of 7%. The Phase II TP MS4 stormwater allocation for the Salina (SC268) Watershed is 13%, with a reserve MS4 stormwater allocation of 7%. Nominal MS4 stormwater allocations are assigned to the Salina (SC268) Watershed until 64% flow exceedance, after which there is no available LC to allocate. Meanwhile, the Phase I TP MS4 stormwater allocation for the Junction City (SC264) Watershed is 2%, with a reserve stormwater allocation of 8%. The Phase II TP MS4 stormwater allocation for the Junction City (SC264) Watershed is 3%, with a reserve MS4 stormwater allocation of 7%. Nominal MS4 stormwater allocations of 2 lbs/day are assigned to flows ranging from 51 to 75% flow exceedance and 1 lb/day is assigned for flows ranging from 76 to 100% flow exceedance. These nominal allocations account for incidences of localized heavy rainfall that may generate runoff conditions when the river is below median flow. Entities permitted for urban stormwater runoff are expected to implement BMPs, as prescribed in their MS4 permits, to the maximum extent practicable in order to reduce runoff and TP loading from developed areas.

Load Allocation

The LA is established to account for nonpoint sources of TP in the watershed. The LA is the remainder of the LC after all other allocations are accounted for. Loads from nonpoint source TP are assumed to be minimal during low flow conditions and grow proportionately as flow conditions increase, thereby accounting for increased runoff during precipitation events. The application of agricultural BMPs in riparian zones near cropland and livestock areas should continue in order to abate and reduce nonpoint source TP loading in this watershed.

Defined Margin of Safety

The margin of safety safeguards against the uncertainty in TP loading in the Smoky Hill River. This TMDL incorporates conservative assumptions to establish an implicit margin of safety. First, five endpoints are established which must be met for three consecutive years before achieving attainment of the water quality standards. Second, concurrently reducing TP and nitrogen discharged from municipal WWTPs is emphasized in order to diminish the often synergistic effects these nutrients have on aquatic life. Third, design flows are used for all point source WLAs, despite the current operation of most facilities under design flow. Fourth, some

facilities are assigned WLAs when it is likely that they do not contribute nutrient loads. Fifth, TMDLs for TP impaired watersheds with tributaries to the Smoky Hill River are being developed concurrently, which will further reduce TP loads to the Smoky Hill River.

The described TMDLs, or LCs, are delineated below for Salina (SC268; **Figure 54; Table 25**), Enterprise (SC265; **Figure 55; Table 26**), and Junction City (SC264; **Figure 56; Table 27**).

Figure 54. Total phosphorus Phase I Total Maximum Daily Load near Salina (SC268) in the Smoky Hill River.

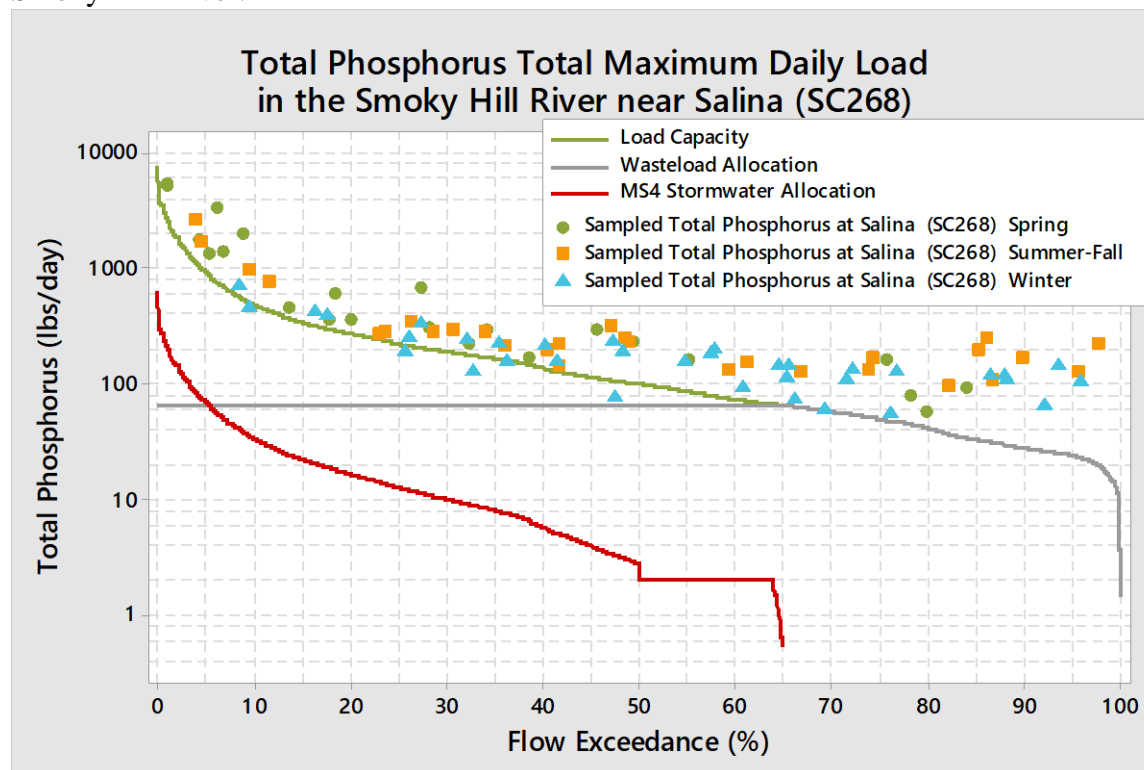


Table 25. Phase I and phase II current load conditions (based upon the median total phosphorus concentration from 2000 to 2017), total load capacity, and load capacity apportionment near Salina (SC268) in the Smoky Hill River.

Flow Exceedance (%)	Flow at Terminus (cfs)	Current Condition (lbs/day)	Load Capacity (lbs/day)	Wasteload Allocation (lbs/day)	MS4 Stormwater Allocation (lbs/day)	Reserve MS4 Stormwater Allocation (lbs/day)	Load Allocation (lbs/day)
<i>Phase I</i>							
90	24	51	27.8	27.8	0.0	0.0	0.0
75	43	91	49.2	49.2	0.0	0.0	0.0
50	87	182	98.9	64.5	2.8	2.2	29.4
25	194	405	219.8	64.5	12.4	10.0	132.9
10	421	880	477.8	64.5	33.1	26.6	353.6

Flow Exceedance (%)	Flow at Terminus (cfs)	Current Condition (lbs/day)	Load Capacity (lbs/day)	Wasteload Allocation (lbs/day)	MS4 Stormwater Allocation (lbs/day)	Reserve MS4 Stormwater Allocation (lbs/day)	Load Allocation (lbs/day)
<i>Phase 2</i>							
90	24	51	17.3	17.3	0.0	0.0	0.0
75	43	91	30.7	30.7	0.0	0.0	0.0
50	87	182	61.7	34.2	3.6	1.7	22.2
25	194	405	137.1	34.2	13.4	6.3	83.2
10	421	880	298.0	34.2	34.3	16.1	213.4

Figure 55. Total phosphorus Phase I Total Maximum Daily Load at Enterprise (SC265) in the Smoky Hill River.

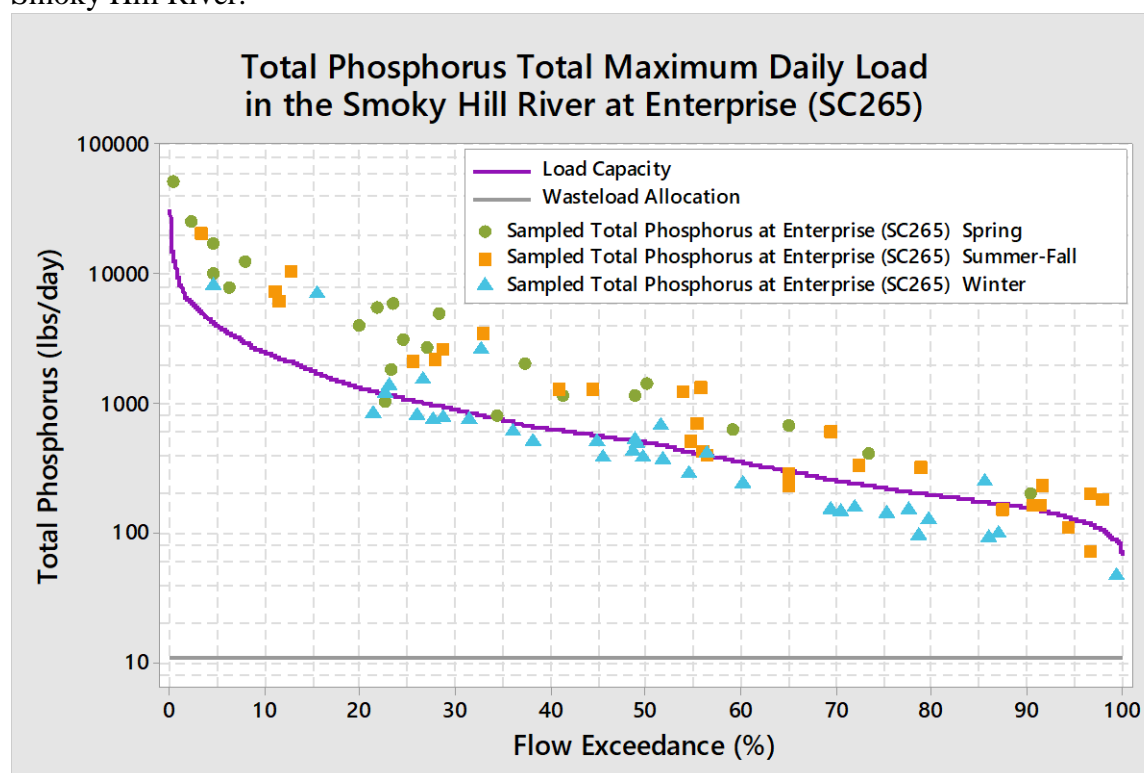


Table 26. Phase I and phase II current load conditions (based upon the median total phosphorus concentration from 2000 to 2017), total load capacity, and load capacity apportionment at Enterprise (SC265) in the Smoky Hill River.

Flow Exceedance (%)	Flow at Terminus (cfs)	Current Condition (lbs/day)	Load Capacity (lbs/day)	Wasteload Allocation (lbs/day)	Load Allocation (lbs/day)
<i>Phase I</i>					
90	140	247.2	158.8	11.1	147.7
75	198	349.6	224.5	11.1	213.4
50	444	784.0	503.5	11.1	492.4
25	956	1,688.1	1084.1	11.1	1073.0
10	2,210	3,902.4	2506.1	11.1	2495.0

Flow Exceedance (%)	Flow at Terminus (cfs)	Current Condition (lbs/day)	Load Capacity (lbs/day)	Wasteload Allocation (lbs/day)	Load Allocation (lbs/day)
<i>Phase 2</i>					
90	140	247.2	99.0	5.6	93.4
75	198	349.6	140.1	5.6	134.5
50	444	784.0	314.1	5.6	308.5
25	956	1,688.1	676.3	5.6	670.7
10	2,210	3,902.4	1,563.4	5.6	1,557.8

Figure 56. Total phosphorus Phase I Total Maximum Daily Load at Junction City (SC264) in the Smoky Hill River.

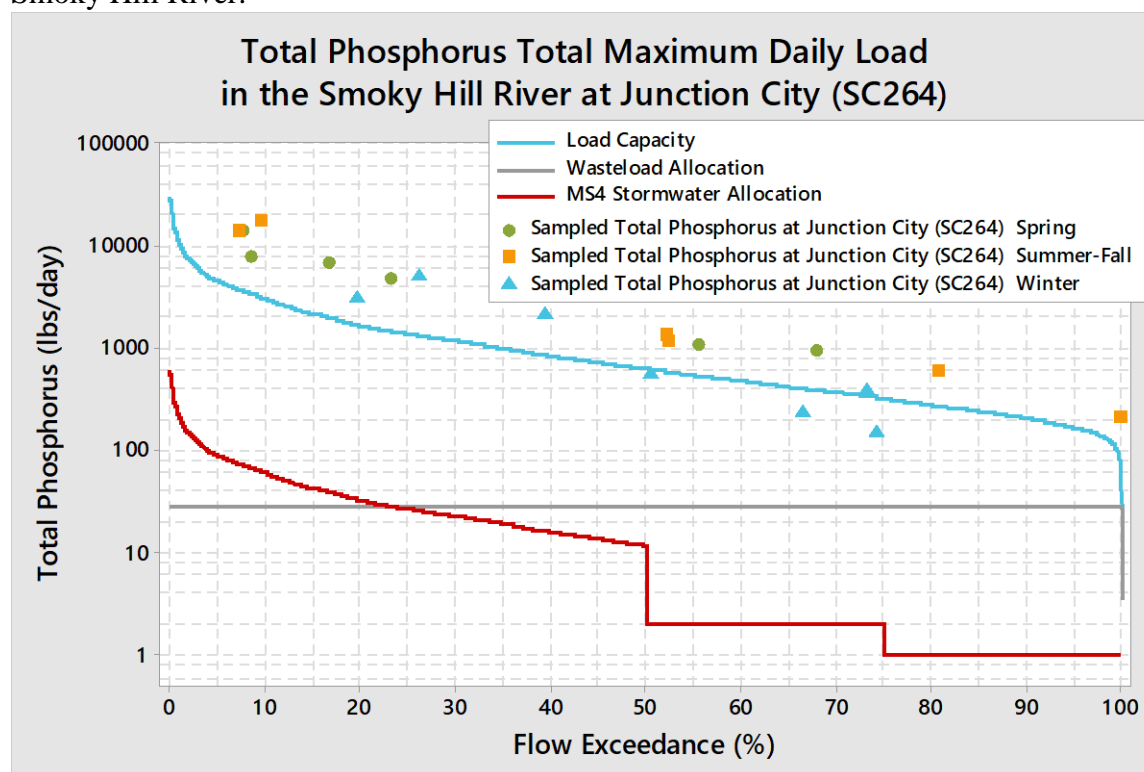


Table 27. Phase I and phase II current load conditions (based upon the median total phosphorus concentration from 2000 to 2017), total load capacity, and load capacity apportionment at Junction City (SC264) in the Smoky Hill River.

Flow Exceedance (%)	Flow at Terminus (cfs)	Current Condition (lbs/day)	Load Capacity (lbs/day)	Wasteload Allocation (lbs/day)	Reserve Wasteload Allocation (lbs/day)	MS4 Stormwater Allocation (lbs/day)	Reserve MS4 Stormwater Allocation (lbs/day)	Load Allocation (lbs/day)
<i>Phase 1</i>								
90	181	496	205.3	27.7	10.3	1.0	1.0	165.3
75	283	775	321.1	27.7	10.3	2.0	2.0	279.1
50	549	1,503	622.6	27.7	10.3	11.7	45.8	527.1
25	1,211	3,314	1,372.8	27.7	10.3	26.7	104.6	1,203.5
10	2,691	7,367	3,051.3	27.7	10.3	60.3	236.2	2,716.8

Flow Exceedance (%)	Flow at Terminus (cfs)	Current Condition (lbs/day)	Load Capacity (lbs/day)	Wasteload Allocation (lbs/day)	Reserve Wasteload Allocation (lbs/day)	MS4 Stormwater Allocation (lbs/day)	Reserve MS4 Stormwater Allocation (lbs/day)	Load Allocation (lbs/day)
<i>Phase 2</i>								
90	181	496	128.0	16.1	10.3	1.0	1.0	99.6
75	283	775	200.3	16.1	10.3	2.0	2.0	169.9
50	549	1,503	388.4	16.1	10.3	10.9	24.6	326.5
25	1,211	3,314	856.4	16.1	10.3	24.9	56.4	748.7
10	2,691	7,367	1,903.4	16.1	10.3	56.3	127.4	1,693.3

Priority HUC12s

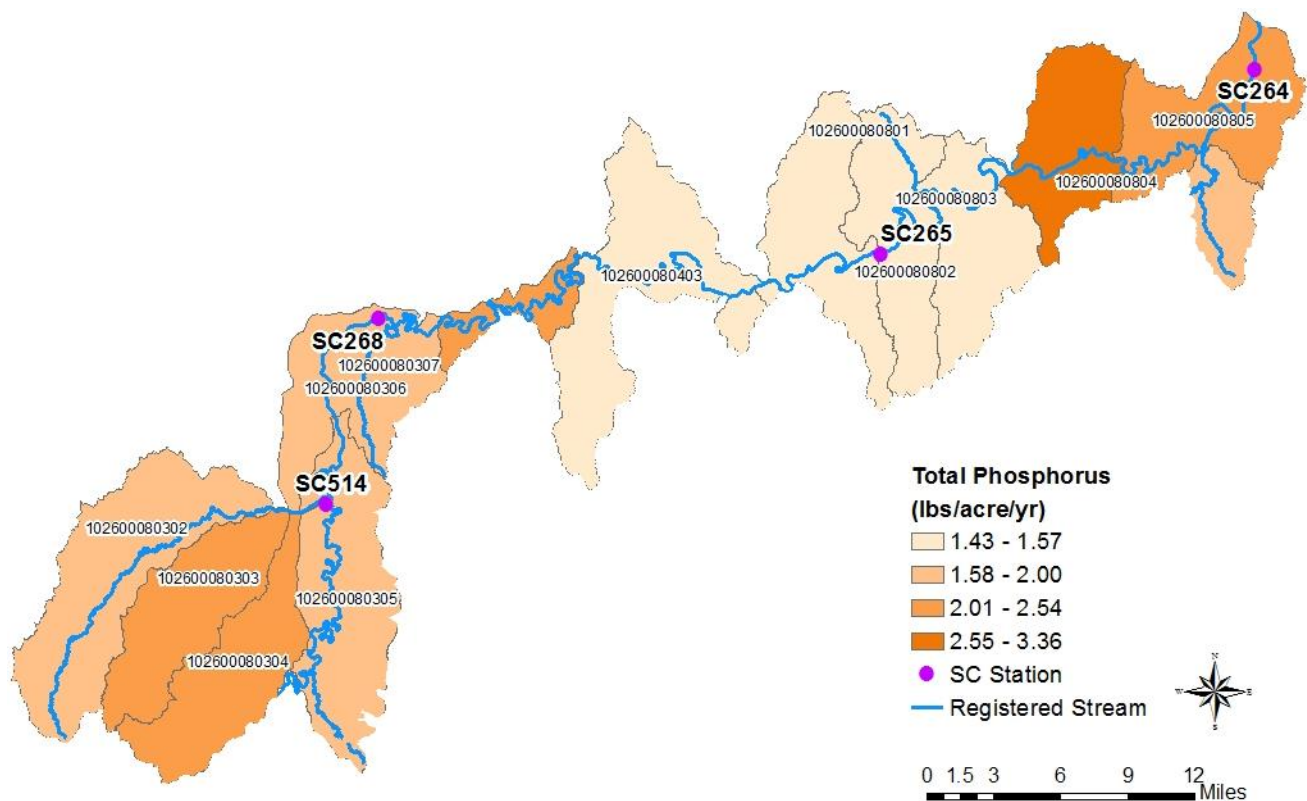
Although this TMDL will initially be driven by implementation of point source treatment improvements, reductions in nonpoint sources will focus on BMP implementation in those HUC12s most impacted by TP loading (**Table 28; Figure 57**). The Smoky Hill River TMDL Watershed consists of 13 HUC12s. According to STEPL, the Smoky Hill River TMDL Watershed high priority HUC12s are: 102600080303 and 102600080304 in the Salina (SC268) Watershed; 10200080307 in the Enterprise (SC265) Watershed; and 102600080706, 102600080804, and 102600080805 in the Junction City (SC264) Watershed. Proactive entities may implement BMPs at any time, with an emphasis on priority HUC12s likely yielding the greatest TP reductions to the Smoky Hill River TMDL Watershed.

Table 28. Priority HUC12s by total phosphorus load according to estimations from the Spreadsheet Tool for Estimating Pollutant Load in the Smoky Hill River TMDL Watershed.

Watershed	Land Area (acres)	Total Phosphorus (lbs/year)	Total (lbs/year/acre)
102600080302	34,785	66,475	1.91
102600080303	22,375	53,298	2.38
102600080304	22,397	56,729	2.53
102600080305	30,698	59,841	1.95
102600080306	23,124	45,785	1.98
102600080307	6,959	16,154	2.32
102600080403	34,072	48,706	1.43
102600080706	31,481	58,166	1.85
102600080801	23,938	37,555	1.57
102600080802	21,769	32,934	1.51
102600080803	19,815	29,675	1.50
102600080804	19,586	65,867	3.36
102600080805	22,634	52,014	2.30

Definitions: **Priority HUC12s**

Figure 57. Map of priority HUC12s by total phosphorus load according to estimations from the Spreadsheet Tool for Estimating Pollutant Load in the Smoky Hill River TMDL Watershed.



State Water Plan Implementation Priority

Due to the prevalence of high TP concentrations in the Smoky Hill River, this TMDL initially focuses on reducing TP loading from point sources, such as permitted NPDES municipal WWTPs and MS4 entities in developed areas. Further reductions in TP loadings will be achieved through effective riparian and land management. Due to the need to reduce the high nutrient loads in the Smoky Hill River, this TMDL will be **High Priority** for implementation.

Nutrient Reduction Framework Priority Ranking

This watershed lies within the Lower Smoky Hill Subbasin (HUC8 10260008), which is among the top 16 HUC8s targeted for state action to reduce nutrients.

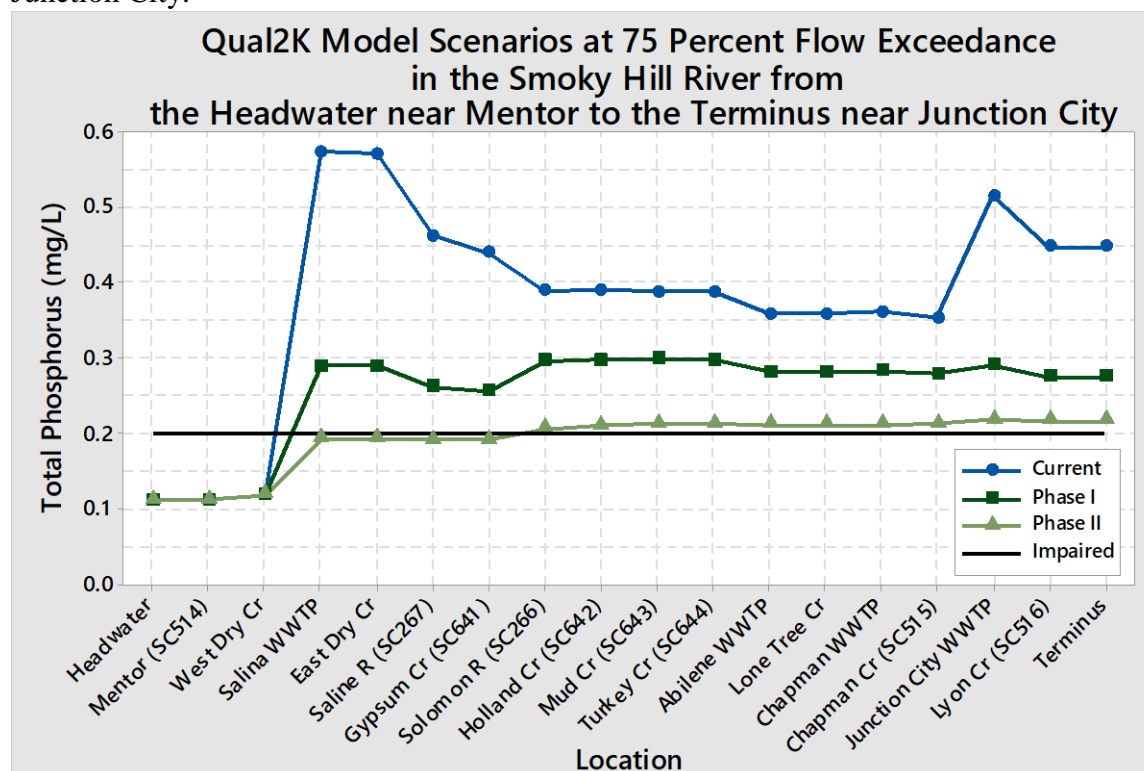
5. IMPLEMENTATION

Point Source Implementation Supporting Information

The steady-state model Qual2K was used to evaluate TP responses in the Smoky Hill River under hydrologic flow conditions representative of the 75th percent flow exceedance (**Figure 58**). This low flow condition captures instances where point sources typically dominate flow and water quality within the river. This flow condition was selected to assess current TP load contributions and evaluate point source load reductions in the Smoky Hill River as data is currently limited at lower flow conditions.

Several scenarios were incorporated into the model runs for the 75th percent flow exceedance condition. Phase I reduces the municipal mechanical dischargers to a TP concentration of 1 mg/L, and Phase II reduces the municipal mechanical dischargers to a TP concentration of 0.5 mg/L. Each of these phases has the most noticeable impact upon the current conditions at the Salina and Junction City WWTPs, the largest WWTPs in the watershed. The model demonstrates that reductions in the major municipal mechanical WWTPs within the watershed will likely result in a TP concentration below or approaching 0.200 mg/L, the concentration delineating a river segment as impaired versus unimpaired for TP within the state of Kansas. Indeed, the phased decreases result in TP concentrations below 0.200 mg/L for approximately a third of the watershed. In order to maintain TP concentrations below 0.200 mg/L throughout the remainder of this watershed at this flow condition, nonpoint source controls will need to be incorporated, particularly on large tributaries such as the Solomon River. The remainder of the watershed has projected TP concentrations near 0.200 mg/L, with the TP concentration at the terminus of the watershed reaching 0.217 mg/L.

Figure 58. Total phosphorus concentrations as modeled by Qual2K at 75 percent flow exceedance in the Smoky Hill River from the headwater near Mentor to the terminus near Junction City.



Though the modeled concentrations are steady state, if the point sources within the watershed are able to comply with assigned WLAs, TP loading to the Smoky Hill River will be reduced. Once this is accomplished, further reductions from nonpoint sources may be necessary in order to maintain or achieve TP concentrations below 0.200 mg/L throughout the watershed.

Desired Implementation Activities

1. Make operational changes in municipal WWTPs to reduce the phosphorus load.
2. Facilitate wastewater reuse for treated municipal wastewater.
3. Renew state and federal permits and inspect permitted facilities for permit compliance.
4. Improve riparian conditions along stream systems by installing grass and/or forest buffer strips along the streams and drainage channels in the watershed.
5. Implement and maintain conservation farming practices—including conservation tilling, contour farming, and no-till farming—in order to reduce runoff and cropland erosion of agricultural areas in the watershed.
6. Perform extensive soil testing to ensure excess phosphorus is not unnecessarily applied.
7. Ensure labeled application rates for chemical fertilizers are followed to reduce runoff.
8. Implement nutrient management plans and ensure that land-applied manure is properly managed to reduce runoff.
9. Establish pasture management practices, including proper stock density, to reduce soil erosion and storm runoff.
10. Ensure proper on-site waste system operations in proximity to main stream and tributary segments.
11. Support implementation efforts of the Upper Lower and Lower Lower Smoky Hill River Watershed Restoration and Protection Strategy (WRAPS).

Implementation Program Guidance

NPDES and State Permits – KDHE

- a. Continue to monitor influent to and effluent from the permitted discharging WWTPs, encourage wastewater reuse and irrigation disposal, and ensure compliance and proper operation of WWTPs to control phosphorus in wastewater effluent.
- b. Establish permit limits by 2025, as determined by KDHE, with the initial implementation of goals and appropriate schedules of compliance for permits issued prior.
- c. Manage the WLA for the watershed to accommodate growth as needed.
- d. Implement SMPs and BMPs in the City of Salina and the City of Junction City to reduce stormwater pollutant loads to the maximum extent practicable.
- e. Establish nutrient reduction practices among urban homeowners to manage chemical application on lawns and gardens through aforementioned SMPs.
- f. Manure management plans, detailing proper land application rates and practices, will be implemented to prevent runoff of applied manure.
- g. Inspect permitted livestock facilities to ensure compliance.
- h. Inspect new permitted livestock facilities for integrity of applied pollution prevention technologies.
- i. Apply pollution prevention technologies to new registered livestock facilities with less than 300 animal units.

Nonpoint Source Pollution Technical Assistance – KDHE

- a. Support Section 319 implementation projects for nutrient management through reduction of phosphorus runoff from agricultural activities.

- b. Provide technical assistance on practices to establish vegetative buffer strips.
- c. Support implementation efforts of the Upper Lower and Lower Lower Smoky Hill River WRAPS, and incorporate long term objectives of this TMDL into their 9-element watershed plans.
- d. Provide technical assistance on nutrient management for livestock facilities and practices which minimize impacts of small livestock operations in the watershed to reduce impacts to stream resources.

Water Resource Cost Share and Nonpoint Source Pollution Control Program – Kansas Department of Agriculture-Division of Conservation (KDA-DOC)

- a. Apply conservation farming practices—including no-till, terraces, and contours—and/or erosion control structures, including sediment control basins and constructed wetlands.
- b. Provide sediment control practices to minimize erosion and sediment transport from cropland and grassland in the watershed.
- c. Encourage residue management to reduce phosphorus loss and transport from cropland runoff in the watershed.
- d. Implement manure management plans.
- e. Install livestock waste management systems for manure storage.

Riparian Protection Program – KDA-DOC

- a. Establish or re-establish natural riparian systems, including vegetative filter strips and streambank vegetation.
- b. Develop riparian restoration projects along targeted stream segments, especially those areas with baseflow.
- c. Promote wetland construction to reduce runoff and assimilate loadings.
- d. Coordinate riparian management within the watershed and develop riparian restoration projects.

Buffer Initiative Program – KDA-DOC

- a. Install grass buffer strips near streams.
- b. Leverage Conservation Reserve Enhancement Programs to hold riparian land out of production.

Extension Outreach and Technical Assistance – Kansas State University

- a. Educate agricultural producers on sediment, nutrient, and pasture management.
- b. Provide technical assistance on buffer strip design and minimizing cropland runoff.
- c. Encourage annual soil testing to determine capacity of field to hold phosphorus.
- d. Educate residents, landowners, and watershed stakeholders about nonpoint source pollution.
- e. Promote and utilize the WRAPS efforts for pollution prevention, runoff control, and resource management.

- f. Educate livestock producers on livestock waste management, land applied manure applications, and nutrient management planning.
- g. Provide technical assistance on livestock waste management systems and nutrient management planning.
- h. Repair or replace failing septic systems which are located within 100 feet of the Smoky Hill River or its tributaries.

Timeframe for Implementation

The City of Salina WWTP (KS0038474), the City of Abilene WWTP (KS0098647), and the City of Junction City WWTP (Southwest Plant; KS0092151) are designed for nutrient removal. These facilities currently have established nutrient goals; however, additional reduction strategies for the major municipal WWTPs should be evaluated by 2021 with any necessary enhanced treatment initiated by the next permit starting in 2025. Urban stormwater and rural runoff management should expand from 2019 to 2029 to ensure nutrients are addressed. Pollutant reduction practices should be installed within the priority subwatersheds after 2019 with follow-up implementation and monitoring continuing through 2029.

Targeted Participants

The primary participants for implementation of this TMDL are the major municipal WWTPs: the City of Salina WWTP (KS0038474), the City of Abilene WWTP (KS0098647), and the City of Junction City WWTP (Southwest Plant; KS0092151). Agricultural operations immediately adjacent to the Smoky Hill River and its tributaries will be encouraged to implement appropriate practices to further reduce phosphorus loads, as well. Watershed coordinators, technical staff of the WRAPS group, conservation district personnel, and county extension agents should coordinate to assess possible nutrient sources adjacent to streams. Implementation activities to address nonpoint sources should focus on those areas with the greatest potential to impact nutrient loading to the river.

Targeted activities to focus attention toward include:

1. Development of high-density urban and residential areas in proximity to streams and tributaries.
2. Informing urban residents on fertilizer and waste management through their respective SMPs.
3. Denuded riparian vegetation and poor riparian areas along the stream.
4. Conservation compliance on highly erodible areas.
5. Unbuffered cropland adjacent to the stream.
6. Total row crop acreage and gully locations.
7. No till or residue management on cropland.
8. Increasing no-till and precision agricultural practices, including cover crops.
9. Sites where drainage runs through or adjacent to livestock areas.
10. Sites where livestock have full access to the stream and it is their primary water supply.

Milestone for 2029

Advancement of necessary and appropriate measures to decrease phosphorus effluent in the City of Salina WWTP (KS0038474), the City of Abilene WWTP (KS0098647), and the City of Junction City WWTP (Southwest Plant; KS0092151) should be widely implemented by the end of 2024. At that time, TP data from the Smoky Hill River stations near Salina (SC268), at Enterprise (SC265), and at Junction City (SC264) should show indication of declining TP concentrations relative to the pre-2018 data, particularly during normal and lower flow conditions. Aquatic life, too, should show improvement in the Smoky Hill River stations near Salina (SB268), at Enterprise (SB265), and at Junction City (SB264).

Delivery Agents

The primary delivery agents for program participation will be the City of Salina, the City of Abilene, the City of Junction City, KDHE, and the Upper Lower and Lower Lower Smoky Hill River WRAPS group.

Reasonable Assurances

Authorities

The following authorities may be used to direct activities in the watershed to reduce pollution:

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.
2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.
3. K.S.A. 2002 Supp. 82a-2001 identifies the classes of recreation use and defines impairment for streams.
4. K.A.R. 28-16-69 through 71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.
5. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation, and management of soil and water resources in the state, including riparian areas.
6. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control nonpoint source pollution.
7. K.S.A. 82a-901, et. seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.
8. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*, including selected WRAPS.
9. The *Kansas Water Plan* provides the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding

The State Water Plan annually generates \$12-13 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watershed and water resources by priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are located within a **High Priority** area and should receive support for pollution abatement practices that lower the loading of sediment and nutrients.

Effectiveness

Use of Biological Nutrient Removal technology in WWTPs has been well established to reduce nutrients, including phosphorus, in wastewater. Agricultural nutrient control has been proven effective through conservation tillage, contour farming, and use of grass waterways and buffer strips; additionally, the proper implementation of comprehensive livestock waste management plans has proven effective at reducing nutrient runoff associated with livestock facilities. Presuming the Phase I milestone is not met, this TMDL will be evaluated after 2025 to assess the reductions in phosphorus loads that have taken place with guidance provided to targeted participants regarding follow-up implementation activities.

6. MONITORING

Monitoring will continue at KDHE stations for TP in the Smoky Hill River near Mentor (SC514), near Salina (SC268), at Enterprise (SC265), and at Junction City (SC264). Biological monitoring will also continue in the Smoky Hill River stations near Salina (SB268), at Enterprise (SB265), and at Junction City (SB264) to assess compliance with the narrative nutrient criteria in the river. Based on the sampling data, the status of the watershed will be re-evaluated during the 303(d) listing process in 2030.

7. FEEDBACK

Public Notice

An active website is established at http://www.kdheks.gov/tmdl/planning_mgmt.htm to convey information to the public on the general establishment of TMDLs and to provide specific TMDLs by river basin. This TMDL was posted to the Smoky-Saline River Basin on this site on November 30, 2018 for public review.

Public Hearing

A public hearing on this TMDL was held on December 14, 2018 in Salina, Kansas to receive public comments. No public comment was received.

Milestone Evaluation

In 2029, evaluation will be made as to the degree of implementation that occurred within the watershed. Subsequent decisions will be made through consultation with local stakeholders and the WRAPS team regarding implementation of nonpoint source reduction strategies and development of additional implementation strategies for the watershed.

Consideration for 303(d) Delisting

The Smoky Hill River segments covered by this TMDL will be evaluated for delisting under Section 303(d) based on the monitoring data from 2019 to 2029. Therefore, the decision for delisting will ensue in the preparation for the 2030 Section 303(d) list. Should modifications be made to the applicable water quality criteria during the implementation period, consideration for delisting, desired endpoints of this TMDL, and implementation activities may be adjusted accordingly.

Incorporation into the TMDL Vision Process, Water Quality Management Plan, and the Kansas Water Planning Process

Under the current version of the Kansas TMDL Vision Process, the next anticipated revision of this TMDL will be after 2024. The revision will emphasize implementation of WRAPS activities and further reduction of nutrients in wastewater discharged by NPDES facilities. At that time, incorporation of this TMDL will be made into the WRAPS plan. Recommendations for this TMDL will be considered in the *Kansas Water Plan* implementation decisions under the State Water Planning Process for fiscal years 2019 to 2029.

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